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# Proceedings of the Seventh Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The Seventh annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in room 103, Medical Building, University of Utah, Salt Lake City, Utah, July 22, 1922.

The meeting was called to order at 10:45 by Chairman A. L. Lovett, a brief business meeting was held, followed by the presentation of papers. The session closed at 3:00 P. M., with the election of officers and other unfinished business.

## PART I. BUSINESS

The business session was called to order by Chairman A. L. Lovett at 10:45 A. M., July 22, 1922. The following were present:

L. O. Howard, Washington D. C.; Mrs. Roy E. Campbell, Alhambra, Calif.; Roy E. Campbell, Alhambra, Calif.; James C. Evenden, Couer d'Alene, Idaho; C. F. Stahl, Riverside, Calif.; Robert K. Vickery, Saratoga, Calif.; Don B. Whelan, Boise, Idaho; Harold R. Hagan, Salt Lake City, Utah; E. L. Barrett, Bountiful, Utah; George I. Reeves, Salt Lake City, Utah; Ira M. Hawley, Logan, Utah; A. O. Larson, Alhambra, Calif.; E. P. VanDuzee, San Francisco, Calif.; Vasco M. Tanner, St. George, Utah; Wyatt W. Jones, Salt Lake City, Utah; George P. Englehardt, Brooklyn, N. Y.; George Bliss Engelhardt, Brooklyn, N. Y; Edgar McLedyard, Salt Lake City, Utah; C. P. Gillette, Ft. Collins, Colo.; and A. L. Lovett, Corvallis, Ore.

The following committees were named by the Chair: Nominating Committee: A. O. Larson, Chairman, Ira M. Hawley, Geo. I. Reeves; Membership: E. J. Newcomer, Chairman, Edwin C. Van Dyke, C. W. Creel; Auditing: Ira M. Hawley.

The report of the Secretary-Treasurer was then presented.

FINANCIAL STATEMENT

| | | | |
|---|---|---|---|
| January 1, 1922 | | | |
| | Amount on hand | | $24.60 |
| Jan. 27, 1922 | | | |
| (1) | 100 Large Envelopes | $2.31 | |
| (2) | Mimeographed Letters | .85 | |
| Feb. 25, 1922 | | | |
| (3) | Affiliation Fee to A. A. A. S. | 5.00 | |
| June 17, 1922 | | | |
| (4) | Buying, Printing & Mailing 100 Post Cards | 3.02 | |
| | Expenditures | $11.18 | |
| June 17, 1922 | | | |
| | Balance on hand | | $13.42 |
| | Amt. due from Am. Assn. Ec. Ent. | | 11.18 |

Following the presentation of papers, the closing business session was held. The nominating committee reported as follows:

Report of Nominating Committee:

We respectfully recommend the following as officers of this association for next year:

For Chairman H. J. Quayle, Riverside, California.

For Secretary-Treasurer E. O. Essig, Berkeley, California.

The report was duly adopted and the officers elected.

Dr. Hawley reporting on the audit of the Secretary-Treasurer report as O. K.

The Editorial Committee was appointed as follows: Chairman Harold R. Hagan, C. P. Gillette.

## PART II. PAPERS

## THE SUGAR-BEET ROOT-MAGGOTT (*TETANOPS ALDRICHI* HENDEL), A NEW PEST OF SUGAR-BEETS[1]

BY I. M. HAWLEY

During July, 1920, fly larvae were found destroying many fields of sugar-beets near Amalga, Utah. Maggots collected at this time were reared by H. J. Pack, and the flies were later determined as *Tetanops aldrichi* Hendel of the family Ortalidae. The flies are about 6 mm. in length, glossy black, with a smoky patch on the costal margin of the wing about one-third of the distance from base to tip. Doctor Aldrich, after whom the insect was named, informed the writer in correspondence that flies of this species have been collected in the Province of Alberta,

[1]Contribution from the Entomological Department, Utah Agricultural College.

Canada, as well as at Burns, Oregon, and Moscow, Idaho, and that, as far as he knows, the larval stage had not been observed previously. The maggots also have been reported as causing considerable damage locally in Idaho by Doctor Titus and in Colorado by Mr. Maxson of the Great Western Sugar Company. With the exception of a possible infestation in Emery County, the destructive work of the insect in Utah appears to be restricted to a few townships in Cache County.

The maggots of *Tetanops* are of the typical dipterous type. They injure beets by feeding on the tap root. The area around the point of attack turns black and the surrounding soil is saturated by the leakage of beet sap. When the beets are small and feeding is just beginning, the roots are often entirely eaten thru. The first indication of the presence of the pests is the wilting of the plants. As feeding proceeds, these plants die and dry up and, by midsummer, fields will show many skips and bare spots. A. H. Bateman, a field man with the Amalgamated Sugar Company, states that in 1921 three hundred and forty acres were rotated because of this pest in the Lewiston District, Utah. He further reports that in 1921 there was an estimated loss of 924 tons in the infested area—about 21 per cent of the crop. In some places 50 to 75 per cent of the plants have been destroyed. Sixty-four maggots have been found around one plant, and beets surrounded by ten to thirty have not been uncommon. A single larva may destroy a beet seedling and apparently three or four are able to kill a beet one and one-half inches in diameter. The greatest damage occurs after thinning, during the last half of June.

The life-history of *Tetanops* has been under observation since July, 1921, when a study of the insect was first undertaken by H. J. Pack and the writer. At this time the maggots were nearly full grown, and in most cases had stopped feeding. They were in an inactive condition from one to six inches from their host and at a depth of one to three inches in the ground. As the summer progressed they moved deeper in the soil and when last examined in September they were found, head downward, at depths of four to thirteen inches. Hibernation must have occurred in the larval stage, for, when fields were first examined on May 15, 1922, about two-thirds were still maggots and one-third were in the pupal stage. Puparia were never deeper than three inches and more often they were just beneath the upper crust, showing that the maggots had migrated upward before they transformed. In fact, the larval tunnels were often found in the dirt. The average pupal period had been determined as fourteen days, and it would seem

therefore that pupation in 1922 occurred mostly during the second and third weeks of May.

By May 22 flies had emerged from pupae collected on May 15, and flies containing immature eggs were taken in the field on the same day. At this time, some beets were just appearing above ground, while others were not yet planted. By May 31, flies were very common in the fields and some contained mature eggs. On June 1 eggs were found in the soil of a cage in the laboratory, and they were obtained in a beet field on the following day. In loose ground the female crawls into crevices in the soil near a plant and deposits her eggs singly or in lots of two to forty. In compact soil the eggs will be found just beneath the surface of the ground, often in contact with the plant and rarely more than an inch from it. Most of the eggs were deposited during the week of June 1 to June 8, and by June 14 most of the eggs had hatched. The egg of *Tetanops* is 1.0 mm. in length, 0.25 mm. in width, slender, slightly curved, glossy white, unmarked, and much smaller at one end. Eggs have been found around nearly every beet plant in many of the fields examined. As high as forty were present around some plants. Eggs were also abundant around lamb's-quarters (*Chenopodium album*), red root (*Amaranthus retroflexus*), and the prostrate pigweed (*Amaranthus blitoides*).

By June 14 a few small larvae were beginning to feed on the tap roots, some as deep as three inches. The characteristic black feeding spot and the soil soaked with beet sap were already present, but wilting had not yet occurred. The pre-oviposition period was found to average about ten days and the egg stage covers five days, so it may be said that maggots will begin working on the beets approximately two weeks after the flies appear.

In nearly all cases where serious infestations of *Tetanops* have occurred the soil has been sandy or a sandy loam, tho they have been found sparingly in heavier soils. Maggots seem to thrive where the moisture content is very low. Flies will oviposit in dry sand, and the resistance that larvae have to lack of moisture was accidentally shown in another way. A flower-pot containing several dozen maggots was misplaced in the laboratory, and as a result was not watered for about two months. When the pot was examined later the maggots were healthy and crawling around in the dry sand. For some reason, these maggots were still in the larval stage on June 17, as the paper is being written. Another deviation from the above life-history has been found in our rearing work. In August, 1920, and again in 1921 a small number (perhaps 2 to 5 per cent) of the larvae in our cages have

transformed to flies. A few flies were also found in beet fields on August 6, 1921. It would seem that a small second brood of flies occurs in most years.

A beet field near Lewiston which had a very heavy infestation of maggots in 1921 was fall-plowed and seeded to wheat. This spring flies were abundant and a few eggs were found around weeds in the wheat but none around the grain itself. Eggs were also present near weeds in a potato field across the road. The nearest beet field was forty rods away, and here flies and eggs were unusually abundant. It would appear that flies sometimes migrate some distance to find suitable breeding places.

The control of *Tetanops* has received little attention up to the present time. Solutions of corrosive sublimate and other materials that may act as ovicides or larvicides were placed around plants on June 6, but the action of these cannot be observed for some time. It is hoped that when we know more about the insect some cultural practice may be found which will furnish an effective and cheap control.

*Tetanops* is apparently a native insect which has fed on weeds for many years and which is now adding the beet to its list of host plants. We rather feel that if early indications are fulfilled, it will this year take its place as one of the three most serious insect pests of beets in Cache Valley.

## METALLIC MERCURY AS AN INSECTICIDE

By A. O. LARSON,[1] *Assistant Entomologist, United States Department of Agriculture*

Dr. K. Kunhi Kannan of the Department of Agriculture of Mysore State, while visiting our laboratory in 1920, mentioned the fact that he had successfully prevented the hatching of Bruchid eggs in India by placing a small amount of metallic mercury in the container. While he was unable to give the identity of the Indian Bruchid, he said that it glued its eggs to the bean as does *B. quadrimaculatus*. He said that without the mercury appreciably decreasing in quantity, its presence in a container completely prevented the development of the eggs. He said that this action of mercury had been a tradition among his people.

As a result of this information three experiments with mercury and the eggs of *B. quadrimaculatus* were carried on at the same time, as follows:

[1]The first experiments were conducted by Perez Simmons, and the last cowpeas were dissected by A. H. Amis.

1. A pint of blackeyed cowpeas in a quart Mason jar were oviposited upon by a few females on September 21 and 22, 1920. On September 22 about a thimbleful of mercury was sprinkled into the jar and the lid screwed on. Shortly after a paraffined rubber ring was put on to exclude mites (*Pediculoides ventricosus*), but this was removed October 18. The beans were examined November 5. They were spread out and examined carefully with a reading glass. Infestation being light, only forty (40) eggs were found, and these were examined under the binocular. No embryos had developed. Marked preference was shown by the parent weevils for blackeyes with fewest wrinkles.

2. September 20, two thimblefuls of mercury were placed in a small vial with a hole in the cork and the vial placed upright in a pint of blackeyed cowpeas in a quart Mason jar. Twenty-three (23) *B. quadrimaculatus* were put in the same day. More weevils were put in September 22. Shortly after, a paraffined rubber ring was put on the jar; this was removed October 18. Examination of the beans was made on November 5, the beans being gone over carefully with a reading glass. One hundred thirty-five (135) eggs were picked out and examined under the binocular with the result that no embryos were found to have developed.

3. Twenty-two blackeyed cowpeas with thirty-nine (39) newly-deposited eggs were put in a small vial with one thimbleful of mercury. These eggs were laid September 20–23 and were put in the vial with the mercury on the 23rd. The vial then was sealed with a paraffined cork. Examination on November 5 showed that no embryos had developed, the eggshells being dry and empty without exception.

Small spots of black mold were found on the beans in all the containers. The paraffined rings and cork were thought advisable to exclude mites, but may have influenced the results. Later duplications of the above experiments, without using paraffin and rubber rings gave the same results, as far as the failure of the eggs to develop is concerned. In these no mold appeared.

On July 22, 1921, several weevils, *B. quadrimaculatus*, were put into a quart Mason jar of clean red ripper cowpeas. The next day, after oviposition had taken place freely, the eggs were examined with the aid of the binoculars, and all eggs that were not properly glued to the seed coat or that appeared to be imperfect in any way were discarded. One hundred (100) were placed in a vial, 3.2 x 10 cm. and an equal number was placed in a similar vial. These eggs were perfect as far as it was possible to determine. Into one vial was placed a little

vial 1.7 x 6.5 cm. containing about 1 cc. of mercury. The smaller vial containing a perforated cork was placed upright and the larger vials were set aside for observations.

In one week it was noted that eggs in the one vial were hatching, while those in the other were not. In another week it was observed that the larvae from the eggs in the one vial had almost all entered the cowpeas, while in the other vial not an egg had hatched.

On August 15th, after removing the vial of mercury, it was found that every egg that had been in the larger vial, along with the mercury, had shriveled up and appeared to have nothing inside of the chorion. These eggs were remarkable for the absence of all contents within. They were absolutely hollow. There was nothing to indicate that development had ever begun.

August 16th the cowpeas in the other vial were dissected and four live pupae, 74 live larvae and 8 dead larvae were found within. 86% of the eggs had actually produced larvae, and others showed embryonic development, while in the other vial there appeared to be absolutely no embryonic development. No mold appeared in either vial.

On July 25th several pairs of weevils, *B. quadrimaculatus*, were placed in a jar of red ripper cowpeas. These weevils oviposited freely, covering the cowpeas with varying numbers of eggs up to 15 or more, but averaging 8 or 9. Most of the weevils died before August 15th, and the greater number of eggs were laid during the early part of the period from July 25th to August 15th; in fact, many of the eggs had hatched and the larvae had entered before the latter date.

On August 15th two hundred of the cowpeas were counted out and placed in two vials 10 x 3.2 cm. Into the one vial was put a small vial (1.7 x 6.5) containing about one-half thimbleful of mercury. The cowpeas were arranged around the small vial which contained a perforated stopper. Tight stoppers were placed in both large vials, and they were placed side by side on a shelf for observation. For convenience they were labeled "mercury vial" and "check vial."

In a short time it appeared that weevils were at work in the "check vial," because borings and frass began to exude from the cowpeas. It soon became evident that the lack of proper ventilation in this vial was being felt by the weevils. They made openings through the seed coat, and three half-grown larvae left the cowpeas and died. By October 29th, mold began to appear in the vial. This mold developed so rapidly that it was feared that it would kill all the enclosed weevils; therefore on November 4th these cowpeas were placed in four clean dry vials similar to the original. These vials were laid down so that

the cowpeas could have an opportunity to dry and retard the development of the mold. On November 7th, adult weevils began to emerge. The vials were examined daily and all emerged adults were removed. On December 9th, after 101 adults had emerged, it was found that the vials were becoming infested with mites, *Pediculoides ventricosus*, which made it necessary to kill all within the vials. The cowpeas were then dissected and the contents tabulated.

Within the "mercury vial" there seemed to be no activity. No borings or frass exuded from the cowpeas; no larvae bored openings in the seed coats, and there was no evidence of the lack of proper ventilation. On Cctober 6th, when it was thought that all the weevils were dead, seven cowpeas were dissected. The last one contained two half-grown larvae which were alive but were very inactive. The remaining 93 cowpeas were set aside for further observation. On December 9th a very small amount of mold appeared in the vial. By January 11th the mold had not increased to any appreciable extent, and no weevils had emerged; so the cowpeas were dissected and the contents tabulated. At this time all the weevils were dead.

| | | | | Adults | | | Larvae | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of Cowpeas | Treatment | No. of Eggs | No. Hatched | No. Emerged | No. un-emerged | No. Pupae | No. full-grown | No. half-grown | No. fourth-grown | No. less than ¼ grown |
| 100 | Mercury | 800 | 643 | 0 | 0 | 0 | 20 | 80 | 244 | 299 |
| 100 | Check | 920 | 814 | 101 | 79 | 61 | 29 | 82 | 154 | 307 |

The above table shows that in the mercury vial only 20 larvae became full-grown and only 80 more became half-grown, while in the check vial 101 adults emerged, 79 were ready to emerge, 61 had become pupae. While all weevils in the mercury vial died, and while only 101 emerged from the other vial, there is no doubt that most of the unemerged adults and pupae, and many of the larvae from the check vial would have emerged if the mites had not made it necessary to kill them.

In the foregoing experiments the presence of the mercury was the only thing that could possibly have caused the eggs and larvae to fail to develop. Only in one case was the mercury in contact with cowpeas, and then it was not in contact with the eggs. The mercurv did not seem to diminish in amount, and as Dr. Kannan said, "It could be used over and over again with no apparent loss."

While the foregoing may not be of practical use in warehouses because of the initial cost of the mercury, it is of scientific interest and

may be put to use as an economical means of combating other insects. The writer has not had an opportunity to try it against clothes moths, but he can see no reason why a vial of mercury in a trunk or closet would not be effective in preventing the hatching of the moths' eggs. If later investigation shows that it will prevent the hatching of these eggs, it would be an economical and convenient method of control, because the initial cost of the mercury would be little, and it would require practically no attention after being placed in the desired location.[2]

## PEACH TWIG-BORER EXPERIMENTS IN CALIFORNIA

(A Preliminary Report)

By W. P. Duruz, *Pomology Division, University of California*

The peach twig-borer (*Anarsia lineatella* Zeller) or peach worm, as it is also known, has again become a very serious pest in California. The loss in shipping and canning fruits in 1920 and 1921, due to the damage of this caterpillar, was estimated at between 20 and 60 per cent of the crop.

Twenty years ago Professor W. T. Clarke[1], of the University of California, reported the results of careful experiments conducted in Placer County and recommended spraying with a lime-sulphur-salt mixture at the time the trees begin to bloom. This advice was accepted and fruit growers reported good control. Thus, spraying with lime-sulphur at the time the buds swell became the standard practice in California, for preventing "wormy fruit."

During the last three years, however, it has been observed that lime-sulphur sprays at this time did not free an orchard of infestation, and the loss caused by this insect became of great concern. Entomologists were not able to remedy the situation because of the lack of experimental work, also on account of the fact that the life history of the insect was in doubt. The effectiveness of present-day spray materials was also an unknown factor that had to be tested.

The great need for more facts was apparent; therefore Professor E. O. Essig and the writer outlined a project with a view of obtaining

[2]The only reference of which the writer has any knowledge is "Mercury as an Insecticide" (abstract) by K. Kunhi Kannan, in the report of the proceedings of the third entomological meeting, held at Pusa, Feb. 3 to 15, 1919, edited by T. B. Fletcher (Entomological Meeting, Pusa, Report of Proceedings, 1919, Volume 2, Pages 761-762.) The writer has not had an opportunity to see this article.

[1]Clarke, W. T., "The Peach Worm," California Experiment Station Bulletin No. 114, 1902.

information on the life history of the peach twig-borer and particularly how to satisfactorily control it.

The following questions required solution:—

1. Does lime-sulphur spray effectively control the peach twig-borer?

2. What are the relative values of lime-sulphur, its substitutes and other spray materials now in use?

3. What is the best time to apply the sprays?

4. What is the life history of the insect? Is there a second generation or only one irregular brood?

## Spraying Experiments

The work was begun in the fall of 1920. Various orchards were inspected with the view of securing heavily infested trees for the purposes of the investigation. About 600 two-year-old almond seedlings at the University Farm, at Davis, were selected for the experiment. Mr. C. D. Gregory, of Winters, kindly volunteered the use of his apricot orchard, while Mr. J. Caughy of Vacaville offered 900 plum trees for spraying tests.

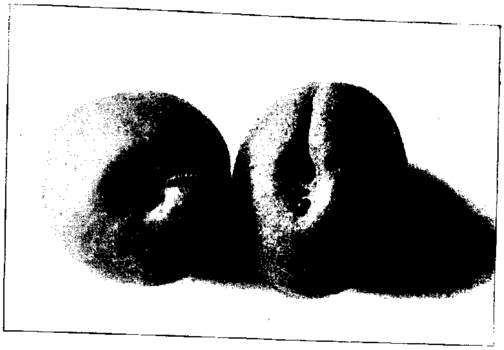
Various spray materials that have been recommended for control of the peach twig-borer were applied to the almond seedlings at Davis at three different stages, in order to determine the proper time of spraying. The experiments at Winters and Vacaville were planned to test the relative values of liquid lime-sulphur and dry lime-sulphur.

Table I shows the results of the 1921 experiments at Davis. Results of the Winters and Vacaville experiments are similar.

It will be noted from the data that nicotine sulphate and zinc arsenite gave excellent control when applied as the buds were swelling and at full bloom. Lime-sulphur controlled the insect only partially, while the lime-sulphur substitutes and the oil sprays were not effective.

The results of experiments in 1921 were used as a basis for more extensive experiments in 1922. Growers in different parts of the state became eager to test suggested remedies and cooperators were secured in Placer, Solano, and Yolo Counties. Professor Essig and the writer outlined and supervised these experiments. In addition to these numerous test plots, the writer, conducted experiments again on the almond seedlings at the University Farm, at Davis.

It is too early to report the results of all the 1922 experiments. In most of the orchards the twig injury caused by the first generation of larvae has not been enough to afford conclusive counts. The almond seedlings are the only ones that showed evidence of injury and counts



Injury to apricot fruit caused by larvae. Attack is usually made at the stem end of the fruit.

Twig of almond, showing characteristic wilting caused by boring of larvae of peach twig-borer.

were made of these tests. The effectiveness of different sprays on the larvae in these trees is shown in Table 2. A summary of two years work on the young almond seedlings is shown in Table 3.

TABLE 1. SUMMARY OF SPRAY APPLICATION FOR CONTROL OF PEACH TWIG-BORER ON ALMOND SEEDLINGS, UNIVERSITY FARM, DAVIS, CALIF., 1921.

| Row No. | Date of Application 1921 | Material and Type of Application | Dilution | No. of Trees Sprayed | No. of Larvae Found | % of Infestation | % Control |
|---|---|---|---|---|---|---|---|
| | | | TREES DORMANT | | | | |
| 10 | 1/31 | Lime-Sulfur "Rex" | 1 in 10 | 18 | 4 | 4.4 | 95.6 |
| 2 plus ½ of 4 | 1/31 | Crude Oil Emulsion | 5% | 6 | 28 | 93.0 | 7.0 |
| 5 | 1/31 | Distillate " | 5% | 16 | 132 | 165.0 | -65.0 |
| 8 | 2/5 | Spra-Mulsion | 1-16 | 30 | 158 | 105.0 | -5.0 |
| | | | BUDS SWELLING | | | | |
| 11 | 2/9 | Lime-Sulfur "Rex" | 1 in 10 | 15 | 20 | 26-⅔ | 73-⅓ |
| 13 | 2/9 | Spra-Mulsion | 1-16 | 16 | 100 | 110.0 | -10 |
| 17 | 2/9 | Nicotine Sulphate (Hard Soap 3 lbs.) | ¼ pt. to 100 gals. | 15 | 2 | 2.5 | 97.5 |
| 19 | 2/11 | B. T. S. | 12-50 | 14 | 9 | 12.0 | 88.0 |
| ½ of 4 | 2/9 | Crude Oil Emulsion | 5% | 6 | 13 | 43.0 | 47.0 |
| 7 | 2/9 | Distillate Emulsion | 5% | 11 | 90 | 163* | -63 |
| | | | FULL BLOOM | | | | |
| 20 | 2/19 | Lime-Sulfur "Rex" | 1 in 10 | 15 | 16 | 21 | 79 |
| 22 | 2/22 | Dry Lime-Sulfur | 12-50 | 14 | 26 | 37 | 63 |
| 23 | 2/19 | Spra-Mulsion | 1-16 | 14 | 53 | 76. | 24 |
| 26 | 2/22 | Zinc Arsenite | 2-100 | 13 | 0 | 0 | 100 |
| 28 | 2/19 | Nicotine Sulphate (Hard Soap 3 lbs.) | ¾ pt. to 100 gals. | 14 | 0 | 0 | 100 |
| 29 | 2/19 | B. T. S. | 12-50 | 15 | 41 | 55 | 45 |
| 7 | 2/19 | Distillate Emulsion | 5% | 13 | 56 | 86 | 14 |
| Unsprayed Trees | | | | 304 | 1395 | 100 | 0 |
| Average per unsprayed tree | | | | | 5 | | |

Note: 5 larvae per tree were taken as a basis in calculating per cent of infestation. The minus quantities are explained bythe more heavy infestations of the trees which are on the east side of orchard.

TABLE 2. PEACH TWIG-BORER CONTROL EXPERIMENTS, UNIVERSITY FARM, DAVIS, CALIF., 1922.

| Row No. | Date of Application 1922 | Material and Type of Application | Dilution | No. of Trees | No. of Larvae found | % of Infestation | % of Control. |
|---|---|---|---|---|---|---|---|
| | | | TREES DORMANT | | | | |
| 3 | 1/5 | Sulco V-B | 1 in 25 | 8 | 2 | 6.66 | 93.33 |
| 4 | 1/5 | Sulco V-B (Nicotine sulphate | 1-25 ¾ pt. - 100 gals. | 12 | 16 | 43.33 | 56.66 |
| 6 | 1/3 | Dry lime-sulphur (S-W) | 12-50 | 20 | 45 | 75 | 25 |
| 7 | 1/3 | Miscible Oil (Spra-Mulsion) | 1-16 | 24 | 33 | 45.8 | 54.2 |
| 8 | 1/5 | Liquid lime-sulphur ("Rex") | 1 in 10 | 29 | 16 | 19.5 | 80.5 |
| 9 | 1/3 | Nicotine sulphate plus Soap | ¾ pt. - 100 gals. 3 lbs. | 17 | 15 | 29.4 | 70.6 |
| 11 | 1/5 | Miscible oil (Zeno) | 1-16 | 18 | 73 | 135 | -35 |
| 12 | 2/3 | Lime-sulphur 1 in 10 plus Arsenate of lead, | 1 in 10 4-100 | 17 | 16 | 31.4 | 68.6 |
| 13 | 2/3 | Arsenate of Lead Casein spreader | 4-100 ¾ lb.-100 | 18 | 30 | 55.5 | 44.5 |
| 14 | 2/6 | Zinc Arsenite Caseih spreader | 2-100 ¾ lb.-100 | 16 | 31 | 64.6 | 35.4 |
| | | | BUDS SWELLING | | | | |
| 16 | 2/11 | Sulco V-B | 1 in 25 | 8 | 16 | 66.66 | 33. 33 |
| 17 | 2/11 | Sulco V-B Nicotine suphate | 1 in 25 ¾ pt.-100 gals. | 8 | 13 | 54 | 46 |
| 18 | 2/11 | Dry lime-sulphur (S-W) | 12-50 | 8 | 14 | 58.33 | 41.66 |
| 19 | 2/11 | Miscible Oil (Spray-Mulsion) | 1-16 | 7 | 12 | 57 | 43 |
| 21 | 2/11 | Liquid lime-sulphur ("Rex") | 1 in 10 | 7 | 0 | 0. | 100 |

TABLE 2 (CONTINUED)

| Row No. | Date of Application 1922 | Material and Type of Application | Dilution | No. of Trees | No. of Larvae found. | % of Infestation | % of Control |
|---|---|---|---|---|---|---|---|
| 22 | 2/11 | Nicotine sulphate plus Soap | ¾ pt.-100 gals. 3 lb. | 7 | 1 | 4.7 | 95.5 |
| 23 | 2/14 | Lime-Sulphur, plus Arsenate of Lead powder | 1 in 10 4-100 | 7 | 2 | 9.4 | 80.6 |
| 24 | 2/18 | Zinc Arsenite Casein | 2-100 ¾-100 | 8 | 38 | 158 | -58 |
| 26 | 2/18 | Arsenate of Lead, powdered, Casein | 4-100 ¾-100 | 8 | 0 | 0 | 100 |
| 29 | 2/4 | Bordeaux Mixture, plus Lead Arsenate Powder (neutral) | 4-5-50 8-200 | 7 | 5 | 23.8 | 76.2 |
| | | FULL BLOOM | | | | | |
| 16 | 3/5 (pink | Sulco V-B | 1 in 25 | 8 | 3 | 12.5 | 87.5 |
| 17 | 3/5 stage) | Sulco V-B Nicotine Sulphate | 1-25 ¾ pt.-100 | 8 | 4 | 16.66 | 83.33 |
| 18 | 3/13 | Dry lime-sulphur (S-W) | 12-50 gals. | 8 | 3 | 12.5 | 77.5 |
| 19 | 3/5 (pink stage) | Miscible Oil (Spra -Mulsion) | 1-16 | 8 | 13 | 54 | 46 |
| 21 | 3/13 " " | Liquid Lime-sulphur ("Rex") | 1 in 10 | 8 | 3 | 12.5 | 87.5 |
| 22 | 3/13 " " | Nicotine sulphate plus Soap | ¾ pt.-100 gals. 3 lbs. | 8 | 0 | 0 | 100 |
| 23 | 3/13 " " | Lime-sulphur "Rex" plus Arsenate of Lead powder | 1 in 10 3-100 | 8 | 1 | 4.1 | 95.9 |
| 24 | 3/14 " " | Zinc Arsenite, powdered plus Casein | 2-100 ¾-100 | 7 | 2 | 9.4 | 80.7 |
| 26 | 3/14 " " | Arsenate of lead, powdered, Casein | 4-100 ¾-100 | 8 | 0 | 0 | 100 |
| 27 | 3/20 | Nicodust | 5% | 8 | 34 | 141.7 | -41.7 |
| 27 | 3/16 | Magnesium Arsenate Casein | 3-100 ¾ lb.-100 | 8 | 4 | 16.66 | 83.33 |
| 28 | 3/21 | (Dry Arsenate of Lead Powdered Hydrated lime, | 10 lbs. 30 lbs. | 8 | 16 | 66.66 | 33.33 |
| 29 | 3/16 | Bordeaux Mixture, Lead Arsenate powder (neutral) | 4-5-50 8-200 | 7 | 10 | 47.6 | 52.4 |
| Unsprayed trees, | | | | 137 | 367 | 100 | 0 |
| Average per unsprayed tree | | | | | 3 | | |

Note: Three larvae per tree were taken as a basis in calculating per cent of infestation. Rains occurred on the following dates: 2/9, 2/10, 2/18, 2/19 and 2/20. First bloom of Almonds recorded March 1.

TABLE 3. PEACH TWIG-BORER CONTROL EXPERIMENTS, UNIVERSITY FARM, DAVIS, SUMMARY OF RESULTS, 1921-1922

| Material and Type of Application | Percent Control 1921 | Percent Control 1922 | Average Percent Control |
|---|---|---|---|
| TREES DORMANT | | | |
| Liquid Lime-sulphur | 95.6 | 80.5 | 88.0 |
| Dry Lime-Sulphur | — | 25. | 25.0 |
| Nicotine sulphate | 97.5 | 70.6 | 84.0 |
| Lime-sulphur, plus Arsenate of Lead | — | 68.6 | 68.6 |
| BUDS SWELLING | | | |
| Liquid lime-sulphur ("Rex") | 73.3 | 100 | 86.6 |
| Dry lime-sulphur | — | 41.66 | 41.66 |
| Spra-Mulsion | -10 | 43 | 16. |
| Nicotine sulphate | 97.5 | 95.5 | 96.4 |
| Arsenate of lead | — | 100 | 100 |
| Lime sulphur, plus Arsenate of lead | — | 80.6 | 80.6 |
| FULL BLOOM | | | |
| Liquid Lime-sulphur | 79 | 87.5 | 83.2 |
| Dry Lime -sulphur | 63 | 77.5 | 70.2 |
| Spra-Mulsion | 24 | 46 | 35.0 |
| Zinc arsenite | 100 | 80.8 | 90.4 |
| Nicotine sulphate | 100 | 100 | 100 |
| Arsenate of lead | — | 100 | 100 |
| Lime sulphur, plus Arsenate of lead | — | 95.9 | 95.9 |

Referring to these tables, it will be observed that liquid lime-sulphur ("Rex") has given an average control of 88 per cent, 86.6 perc ent and 83.2 per cent at the three different stages. The addition of arsenate of lead increased the efficiency of lime-sulphur, in the full bloom spray. The arsenicals also were highly efficient in controlling this insect, especially when spraying was done during the blooming period; when applied earlier the rains washed them off before the caterpillars emerged. Nicotine sulphate has given a higher average control than any other spray tested. It is most effective during full bloom, however.

## Life History Experiments

Evidences of a Second Generation. As has been previously stated, there have been conflicting theories regarding the life history of the peach twig-borer. Evidence is here presented to prove the existence of a distinct second generation, rather than one irregular brood.

The writer has followed closely the activities of the insect at Davis and these observations agree closely with those of Clarke made in Placer County in 1902. In order to prove that these observations were not those of only a few chance individuals, careful counts were made on each of 562 almond seedlings. The infested shoots were counted first between April 1 and 21, in comparing the effectiveness of the spray treatments already discussed. A second count was made between June 10 and 13.

Considering only the unsprayed check trees (numbering 304), there was an average of five larvae per tree at the first count. After April 21, there was no indication of an irregular infestation; all the larvae had pupated and there were no "stragglers." On June 8th large numbers of larvae were again noticed attacking the twigs on these trees. The second count was then made over the entire orchard, and a tremendous increase in number of larvae was found. There was an average of 12.5 larvae per tree at this time, showing an increase of 150 per cent in approximately one month. What is more significant is the fact that the sprayed trees, some of which showed no infestation in the first count, had the same average number per tree as the unsprayed trees. The increase in number and spread of the attack is attributed to egg laying and the flight of the moths. This is conclusive proof of the existence of a definite second generation. (The writer believes from his general observations that there is a third distinct generation also, but has not had opportunity to collect positive data.)

## Conclusions

The results of two years investigation are not conclusive enough to warrant definite recommendations. Some very good "leads" have been

obtained, however. Lime-sulphur alone can not be regarded as a satisfactory remedy. The addition of arsenate of lead (neutral or basic) or nicotine sulphate to lime-sulphur, and this mixture applied as near the pink stage as possible is considered to be the best control for the peach twig-borer at the present time. If lime-sulphur spraying is not necessary for fungous diseases, nicotine sulphate sprayed at blooming time is recommended.

On account of the fact that there is a second generation, one spraying may not be sufficient. If complete control is not secured in a given district, the flight of surviving moths may scatter and multiply the infestation and "wormy fruit" will be the result. A spray applied the middle of May will probably reduce the fruit damage. The writer is testing the effectiveness of nicotine sulphate and arsenate of lead against the second generation of larvae and will be able to report results at the end of this season.

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## RESISTANCE OF CERTAIN SCALE INSECTS IN CERTAIN LOCALITIES TO HYDROCYANIC ACID FUMIGATION

By H. J. Quayle, *Citrus Experiment Station, Riverside, California*

In 1915 my attention was called to the unsatisfactory results of fumigation for the citrus red scale, *Chrysomphalus aurantii* Mask., that had been obtained in the vicinity of Corona, California. The red scale was very abundant in several groves in spite of the fact that the trees had been fumigated not only regularly in the fall but the more severely infested trees had been fumigated also in the spring. This condition is known to have prevailed for some years previous to 1915 and still prevails.

Ordinarily, the so-called 100- or 110-percent schedule of dosage is effective in controlling the red scale, but this schedule was considerably increased in the commercial fumigation work in the Corona district with the result as indicated above. In our experimental fumigation work there since 1915, dosages varying from 100 to 200 per cent for the regular period of 45 to 50 minutes, and dosages of from 75 to 100 per cent repeated at the end of the regular period, were given with unsatisfactory results. This experience, together with that of several different commercial firms, led us to suspect that the red scale is actually more difficult to kill in that district, rather than to ascribe the poor

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results to insufficient dosage, leaky tents, or lack of attention to the details of the work.

The time and place may very materially affect the results of fumigation, hence in any comparative work it is necessary to eliminate these two variable factors. This was done in the case in question by taking infested fruits from two localities and fumigating them under the same tent in a third locality. The fruits infested with red scale were picked from two localities on the same day, or from one of the localities on the day following. They were placed in the same basket, or two baskets were placed together under the tent, in order to guard against variation in gas concentration in different parts of the tent. Different series of such tests have been made repeatedly since 1915 under tents over "form trees," under tents in experimental fumigation work in the field, and under tents operated in commercial fumigation practice. Since 1915 it has been determined that the red scale in certain districts in Orange County manifests the same apparent resistance to hydrocyanic acid.

In the comparative tests reported below the dosage was varied considerably, but in all cases the scales from the different localities were under essentially identical conditions.

The summary results of a few representative tests are given below in table 1.

TABLE 1. THE EFFECT OF FUMIGATION ON RED SCALE FROM DIFFERENT LOCALITIES

| Locality | No. of scales fumigated | No of scales alive | Percentage of scales alive |
|---|---|---|---|
| | SERIES I | | |
| Orange | 6,076 | 35 | 0.57 |
| Corona | 10,176 | 455 | 4.47 |
| | SERIES II | | |
| La Habra | 1,388 | 6 | 0.43 |
| Corona | 1,430 | 280 | 19.58 |
| | SERIES III | | |
| Riverside | 1,386 | 1 | 0.07 |
| Corona | 1,773 | 12 | 0.67 |
| | SERIES IV | | |
| Redlands | 2,300 | 6 | .26 |
| Highgrove | 2,700 | 49 | 1.81 |
| Corona | 4,300 | 173 | 4.02 |
| | SERIES V | | |
| La Habra | 1,500 | 60 | 4.00 |
| Corona | 1,900 | 388 | 20.40 |

The fact that we have evidence extending over a period of seven years of exceptional resistance in the red scale at Corona, and in a district in Orange County extending over four or five years, would indicate that it is not necessarily a seasonal condition. If it is a case of acquired immunity and the factor of resistance is hereditary, it is necessary that this factor be transmitted through two or three generations of scales since this number intervenes between fumigations. We have some evidence to indicate that the individuals that are alive after

one fumigation are more resistant to a second fumigation than individuals which have not been previously fumigated. Also, that the greatest resistance is shown by scales on trees that have been fumigated regularly, once, or even twice, a year. More satisfactory fumigation results have often been secured on trees that have not been fumigated for two or three years than on trees that have been regularly fumigated where a certain number of the scale escaped being killed.

The variable factors of time and place affecting fumigation results have to do chiefly with meteorological conditions. There is also a variation in the condition of the tree itself, but this may be independent of the time or locality. Differences in the amount of foliage on the tree may influence fumigation results. Foliage absorbs hydrocyanic acid, and the more foliage there is present the more HCN will be absorbed and the less, apparently, will be left in the atmosphere to kill the insects on the exterior of the tree.

A series of tests were made to determine the relation of the foliage to the dosage. An ordinary orange tree with a medium amount of foliage was covered with a tent, and alongside this tree a wooden framework was constructed to support a tent, which enclosed a space identical in form and size with the orange tree. Lemons infested with red scale were placed in the same relative position under each tent. The tents were frequently interchanged to overcome tent variation. The dosage was varied, but was always the same under both tents in any given test. These tests showed that the proportion of scales killed was approximately 5½ per cent greater under the tent that contained no tree or foliage.

It has been noted in the field that on the heavy foliage-Lisbon type of lemon tree, scales are more likely to survive a fumigation than scales on trees with sparse foliage. Scales are much more difficult to kill on the fruit than on the twigs or leaves. Likewise, they are more difficult to kill on vigorous and thrifty leaves, and on vigorous shoots such as suckers, than on less thrifty leaves and twigs. This difference in resistance on different parts of the tree, or between two trees of different vigor, seems to be related to the food supply of the scale. If a particular locality had a monoply on the vigorous trees, the resistance of the insects might be explained on this basis, but the red scale is more difficult to kill on unhealthy trees in the areas where it shows exceptional resistance, than on healthy trees in other localities. The tree may constitute one of the variable factors in fumigation results, but that scale resistance is not entirely determined by the tree, is shown by the tests given. Here the resistance persisted after the scale-infested fruit was removed from the tree and fumigated in a different locality.

Certain stages of the red scale show more resistance to HCN gas than others. The molting period, particularly the second molt, and the adult or young-producing period, are the two most resistant stages, and of these two, the molting stage is the more resistant.

Among the variable meteorological conditions, humidity and wind are important, as affecting the results of fumigation. The ordinary canvas tenting material varies greatly in gas-holding capacity according to the dryness of the cloth, which is dependent upon the amount of humidity in the atmosphere, and also, varies according to the movement of the atmosphere. By means of a gas-tight tent we have been able to overcome the effect of humidity on the tent, and have eliminated tent leakage, the most variable factor in fumigation work. By the use of a gas-tight tent in different localities, further proof of exceptional scale resistance in certain localities has been secured.

In the case of the red scale at Corona, definite proof of resistance was lacking until comparative tests were made in which the variable factors of time and place were eliminated. At this time, however, after seven years' experience, observation of experimental and commercial work in the field is sufficient to establish the fact of resistance.

In 1915 our attention was also called to the difficulty of killing the black scale in the vicinity of Charter Oak, California.

Because the black scale does not infest the fruit (at least to any considerable extent) it has not been possible to carry out comparative fumigation tests on it from two or more localities at the same time, and in the same tent, as with the red scale. Infested twigs can be collected from different localities, however, although drying interferes with the results and is difficult to overcome. Our experimental fumigation work, as well as commercial work in the Charter Oak district for the past six years, furnishes ample proof that the black scale is much more difficult to kill with HCN gas there than in most other localities. In general, the black scale is most susceptible to HCN gas when it is small. When it reaches the mature stage fumigation results are much less satisfactory. In the Charter Oak district, however, with dosages greatly in excess of that ordinarily necessary to secure a 100 per cent kill, small scales in considerable numbers will come through the fumigation unharmed. In most other localities 25 per cent less gas would insure very satisfactory results on similar small scales.

There are thus two localities where it seems well established that the red scale is very resistant to hydrocyanic acid gas, and one locality where the black scale is specially resistant. In these localities these scales are

not immune to hydrocyanic acid, but the dosage required for satisfactory results is so large that effective fumigation is unsafe for the tree except under the most favorable conditions.

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# FACTS CONCERNING MIGRATION OF BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER) IN SACRAMENTO VALLEY OF CALIFORNIA

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## I. INTRODUCTION

According to Ball (1) the beet leafhopper (*Eutettix tenella* Baker) is not found, except in periods of abundance, in the inland regions north of Sacramento. Ball (1) reports that during the serious outbreaks of curly leaf (curly top or blight) in 1914, considerable damage to the beet crops occurred at Hamilton City. After several years of idleness the sugar factory at Hamilton City resumed operations during 1918. This sugar mill was closed after the 1918 outbreak of curly leaf and since then has not operated.

## II. CURLY LEAF

We (2) have published the results of our investigations conducted in the Sacramento Valley during 1918. In the beet fields near Hamilton City, not a single beet leafhopper was captured on June 6, and no blighted beets were found. Spring brood adults, however, were taken on garden beets at Marysville on June 2, but 5% of these beets were diseased, indicating an earlier invasion of the pest. A trip was taken into the Sacramento Valley on August 19-25, and from 66-86% of the sugar beets showed curly leaf symptoms, in the vicinity of Hamilton City. In the southern part of the valley from 36-86% of the beets were blighted.

During 1919, at least one or two trips per month were taken to all of the beet centers in the Sacramento Valley during the beet season. The first beet leafhopper was captured on Silverscale or Fog Weed (*Atriplex expansa*) near Woodland on May 27, but no curly leaf was found in the late planted beet fields. The average percentages of curly leaf in the various beet districts developed as follows during the past season.

| | West Sacramento | Woodland | Knights Landing | Meridian |
|---|---|---|---|---|
| | % | % | % | % |
| April 27 | 0 | | | |
| May 27 | 0 | 0 | 0 | |
| June 16 | | 5 | 8 | |
| June 22 | | 6 | 22 | 68 |
| July 19 | 74 | 31.5 | 72 | 74 |
| August 30 | 100 | 79 | 100 | 96 |

In the Sacramento Valley beets are planted from February to May and records of curly leaf were obtained during 1920 with reference to the time of planting. Five fields were selected in the Meridian beet districts and the percentage of curly leaf in each field was determined twice per month. Spring brood adults were rarely captured in the Meridian beet fields on May 27, and at Davis about 40 miles south on May 26. The dates of planting, number of irrigations, percentage of curly leaf and yield per acre are indicated in table 1.

TABLE 1. PERCENTAGES OF CURLY LEAF AND YIELD PER ACRE IN MERIDIAN BEET FIELDS DURING 1920.

| Field | Number of acres | Dates of p anting | Number of irrigations | Percentages of curly leaf | | | | | | Tons per acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 5/27 | 7/1 | 7/12 | 7/20 | 8/9 | 8/26 | |
| 1 | 256 | Feb. 14 | *3 | - - | 12 | 20 | 26 | 62 | 84 | 8.3 |
| 2 | 37 | Feb. 16 | 2 | - - | 14 | 28 | 54 | 88 | 98 | 5.37 |
| 3 | 47 | Mar. 6 | 2 | - - | 4 | 14 | 16 | 48 | | 10.2 |
| 4 | 62 | Mar. 14 | 2 | - - | 14 | 32 | 52 | 92 | 96 | 4.6 |
| 5 | 35 | Apr. 2 | 1 | - - | 14 | 30 | 56 | 1 0 | 100 | 2.7 |

- - = less than 1% curly leaf. *=1 pre-irrigation, 2 summer irrigations.

It is evident from table 1, that the lowest tonnage was obtained in the April planted beet field.

During 1921, however, an earlier invasion of the beet leafhopper in the Sacramento Valley occurred. Two spring brood adults were captured on April 15, in half an hour at sunset in a beet field planted early in March at Woodland. No blighted beets were found. The leafhopper was not taken in the Meridian beet fields, about 30 miles north of Woodland on April 16 nor on April 30, when further investigations were discontinued.

During 1918–1920, the first appearance of curly leaf in the Sacramento Valley was about a month later than in the northern portion of the San Joaquin Valley due to a later invasion of the pest. On July 1, 1920, 14% of the March and April planted beet fields (Table 1, fields 4, 5) were blighted in the Meridian district of the Sacramento Valley compared with 94–100% at Union Island and Lathrop in the northern part of the San Joaquin Valley. It is evident that such factors should have a direct bearing on the average tons per acre harvested.

### III. Average Tons Per Acre in Sacramento and San Joaquin Valleys

During the past four outbreaks of the beet leafhopper the average tons per acre harvested in the Sacramento Valley and northern part of the San Joaquin Valley was as follows:

| | Sacramento Valley | | San Joaquin Valley |
|---|---|---|---|
| 1918 | 8.49 | | 5.58 |
| 1919 | 6.02 | | 3.46 |
| 1920 | 6.92 | | 5.12 |
| 1921 | 6.72 | | 4.86 |
| | 7.02 | Average | 4.96 |

The average tons per acre would be lower if the acres abandoned on account of curly leaf were to be taken into consideration.

It is evident that the lowest average tonnage per acre was obtained during 1919 when the beet leafhoppers reached their maximum in numbers. Again in 1921, the average tons per acre was lower than in 1918 and 1920. In California general outbreaks of curly leaf occurred during the following years: 1899–1900; 1905; 1913–1914; 1918–1919–1920–1921. It is evident that with the exception of 1905, and 1918–1921, the outbreaks of curly leaf occurred in two successive years, with the drop in tonnage due to the disease greater in the second year. During the four successive years of curly leaf, the drop in tonnage due to the disease was greater in the second and fourth years and it appears, seemingly, that a double two year outbreak of the blight has occurred.

During the three year interval between the 1913–1914 and 1918–1921 outbreaks of curly leaf, the average tons per acre in the Sacramento Valley and northern part of the San Joaquin Valley was as follows:

| | Sacramento Valley | | San Joaquin Valley |
|---|---|---|---|
| 1915 | 9.17 | | 7.75 |
| 1916 | 10.65 | | 8.49 |
| 1917 | 9.76 | | 6.73 |
| | 9.94 | Average | 7.29 |

### IV. Spring Migration

We (3) have published the results of our investigations concerning a spring migration of the beet leafhopper into the Sacramento Valley. The evidence for a spring migration during 1918–1920, is associated with the fact that the first brood adults did not invade the cultivated area after the pasture vegetation became dry on the foothills and again, no specimens were found wintering over on the foothills during 1920–1921.

## V. Autumn and Winter Investigations

Cultivated Area.—An attempt was made to determine whether an autumn dispersion to the foothills of the Sacramento Valley occurred. After the beets were harvested, the leafhoppers were found on saltbushes, pigweeds and other green plants during October 1920. During November and December the hoppers became fewer on green vegetation growing on the valley floor. The last record of the dark winter adults in the cultivated area was obtained at Clarksburg on January 6, 1921, when eight specimens were taken on a few beets still remaining in a field after the crop had been harvested.

Foothills of Coast Range.—The most intensive investigation was conducted during the autumn and winter, on the barren foothills of the Coast Range and Marysville Buttes covered with the most favorable winter host plant, namely, the Red Stem Filaree (*Erodium cicutarium*). No dark winter adults were found on the foothills which had not been cultivated. On the cultivated hills west of Yolo, two beet leafhoppers were captured on November 3, on a small patch of Red Stem Filaree growing in the vicinity of a watering trough, before the pasture vegetation had germinated. Specimens were also taken on weeds growing on the cultivated hills and on oleander. There was very little green vegetation available for the insects to feed on. After the pasture vegetation had germinated, a few adults were again taken on Red Stem Filaree at sunset on November 28, and a half dozen males on oleander. A trip was taken to the same locality on December 2, and a single male was found on Red Stem Filaree, but none on oleander.

The eastern foothills of the Coast Range bordering the western side of the Sacramento Valley were examined several times from October 1920 to February 1921. The beet leafhopper was not found wintering over on the uncultivated, barren foothills. The location of the foothills examined from north to south with reference to distances and directions of the nearest towns follow:

25 miles west of Cottonwood.
 Vicinity of Newville and Paskenta.
12 miles southwest of Willows.
 Vicinity of Sites.
10 miles west of Williams.
 Vicinity of Brooks in Capay Valley.
 Vicinity of Capay.
 Yolo Hills, near Blacks.
 Vicinity of Vacaville.
 Montezuma Hills, vicinity of Collinsville.

FOOTHILLS OF SIERRA NEVADA MOUNTAINS.—An investigation was also conducted on the western foothills of the Sierra Nevada Mountains bordering the eastern side of the Sacramento Valley. The foothills are often rolling or merely undulating and the timbered region is soon reached after leaving the valley slopes. Red Stem Filaree is not abundant on the hills. The beet leafhoppers were not taken on the western foothills of the Sierra Nevada Mountains bounding the Sacramento Valley and there were no indications on this side of typical Eutettix foothill breeding grounds. The location of the Sierra Nevada foothills from north to south with reference to distances and directions of the nearest towns follows:

7 miles northeast of Red Bluff.
10 miles east of Chico.
Vicinity of Oroville.
12 miles east of Marysville.
Vicinity of Newcastle.
Vicinity of Ione.

## VI. FAVORABLE BREEDING PLANTS OF BEET LEAFHOPPER IN CULTIVATED AREA

In the cultivated area of the Sacramento Valley the most favorable breeding plants such as the saltbushes are scarce, except in the southern part of the valley. The beet leafhopper has been bred from the following species of the family Chenopodiaceae, to which the sugar beet belongs:

TABLE 2. SPECIES OF CHENOPODIACEAE FROM WHICH BEET LEAFHOPPER HAS BEEN BRED

Annual Saltbushes

1. Silverscale or Fog Weed (*Atriplex expansa*). Native.
2. Bractscale (*Atriplex bracteosa*). Native.
3. Redscale or Red Orache (*Atriplex rosea*). Introduced from Europe.
4. Crownscale (*Atriplex coronata*). Restricted to California.
5. Heartscale (*Atriplex cordulata*). Restricted to California.
6. *Atriplex parishi*. Restricted to California.
7. Spearscale (*Atriplex patula*). Native. The beet leafhopper has not been bred from this saltbush.

Perennial Saltbushes

8. *Atriplex fruticulosa*. Restricted to Sacramento and San Joaquin Valleys.

Pigweeds

9. Pigweed or Lamb's Quarters (*Chenopodium album*). Common European weed.
10. Nettle Leaf Goosefoot (*Chenopodium murale*). Naturalized from Europe.
11. Mexican Tea (*Chenopodium ambrosioides*). Naturalized from tropical America.

Weeds

12. Russian Thistle (*Salsola kali tenuifolia*). Introduced from Asia.
13. *Nitrophila occidentalis*. Native.

In the Sacramento Valley, the beet leafhopper was bred from Orchard Morning Glory (*Convolvulus arvensis*) which is the most troublesome weed in the beet fields of California.

## VII. Climate

It is evident that the food and breeding plants on the foothills of the Coast Range and in the cultivated region of the Sacramento Valley are not the limiting factors which prevent the beet leafhopper from establishing itself. Climatic barriers determine whether the foothill breeding grounds are unfavorable to the beet leafhopper in this valley. A comparison of the humidity, sunshine and temperature in the migratory and natural breeding areas will be given.

Humidity.—The winter humidity is high on account of the rains and fogs in the Sacramento Valley. A low atmospheric humidity accompanied by cloudless skies is usual throughout the summer. In the southern portion of the valley the relative humidity is about 10 per cent higher than at the northern part.

Precipitation.—A comparison of the average rainfall in the Sacramento and San Joaquin Valleys shows some striking differences. The rainfall increases northward in the Sacramento Valley and varies from 19.28 inches at the city of Sacramento near the southern boundary of the valley to 24.9 inches at Red Bluff in the northern extremity. The precipitation is considerably less upon the west side of the valley than in corresponding localities upon the east side. The rainfall along the west side decreases from the south to about the central part of the valley and then increases to Red Bluff. The rainfall along the east side increases from south to north throughout the valley. The following figures show the average rainfall from south to north at the weather bureau stations situated in the western and eastern halves of the valley:

Table 3. Average Rainfall from South to North in Sacramento Valley

| Western Half | Inches | Eastern Half | Inches |
|---|---|---|---|
| Vacaville | 26.65 | Sacramento | 19.28 |
| Woodland | 18.29 | Marysville | 20.39 |
| Colusa | 16.21 | Oroville | 27.75 |
| Willows | 16.41 | Chico | 23.14 |
| Corning | 21.36 | Red Bluff | 24.92 |

In the San Joaquin Valley the rainfall decreases from north to south, and with minor exceptions is considerably less on the west side of the valley than on the eastern side. Stockton, in the northern part of the San Joaquin Valley has an annual rainfall of 14.57 inches while Bakers-

field, in the southern part of the valley has 5.39 inches. Table 4, gives the annual rainfall of towns on the western and eastern sides of the valley:

TABLE 4. AVERAGE RAINFALL FROM SOUTH TO NORTH IN SAN JOAQUIN VALLEY

| Western Half | Inches | Eastern Half | Inches |
|---|---|---|---|
| Antioch | 12.94 | | |
| Tracy | 10.37 | Milton | 21.90 |
| Westley | 10.66 | | |
| Newman | 11.88 | La Grange | 16.91 |
| Los Banos | 8.52 | | |
| Dos Palos | 8.29 | | |
| Mendota (near valley trough) | 6.29 | | |
| Coalinga | 8.06 | Lemoncove | 15.95 |
| Maricopa | 8.04 | Porterville | 10.02 |

FOG.—Fog is common during the winter months, but decreases in density and frequency of occurrence northward in the Sacramento Valley. In the southern part of the valley, fog is dense during the night and morning, but frequently disappears or lifts during the day, though sometimes continuing as a high fog for several days. The lower lying parts of the valley are sometimes subject to light fogs in the autumn and spring, when other portions are free from it.

Fog probably delays the spring migration of the beet leafhopper into the Sacramento Valley. During foggy days the bugs are sluggish and inactive, and when fog occurs before sunset no activity is displayed by the adults.

DEW.—An unfavorable factor to the overwintering beet leafhopper may be the heavy dew which occurs during the rainy period in the Sacramento Valley.

SUNSHINE.—The Sacramento and northern part of the San Joaquin Valleys have a lower percentage of sunshine than the middle and southern San Joaquin Valley.

TEMPERATURE.—The foothill slopes up to about 1,200 feet elevation in the Sacramento Valley have a minimum temperature during the winter months of 1° to 5° higher than that over the flatter and lower part of the valley floor. The difference in temperature between the sloping positions and the valley floor ranges from about 5° to 8° in the upper San Joaquin Valley.

## VIII. BARRIERS

In all probability the exterminating factor of the overwintering beet leafhopper in the Sacramento Valley is humidity. The rainfall in this valley varies from 19.28 to 27.75 inches. The hot dry summers in the

Sacramento Valley are favorable to the migrant and later generations in the cultivated area.

Since our investigations were conducted in the Sacramento Valley during the past four successive outbreaks of the beet leafhopper from 1918–1921, we have no evidence to show whether the pest is found only in this valley during periods of abundance as suggested by Ball (1). Future observations will determine whether a migration takes place into the Sacramento Valley in years when no general outbreak of the beet leafhopper occurs.

## IX. Acknowledgments

We are deeply indebted to Mr. G. E. Springer, General Manager and the Board of Directors of the Alameda and Union Sugar Companies for employing Mr. A. J. Basinger and financing the work during the beet season of 1920–1921. The Atriplexes were kindly determined by Dr. H. M. Hall and the common names of the saltbushes used in this paper will appear in a forthcoming monograph from the Carnegie Institution, Washington, D. C.

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# FACTS CONCERNING NATURAL BREEDING AREA OF BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER) IN SAN JOAQUIN VALLEY OF CALIFORNIA

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## I. Introduction

Sugar mills have been built in a natural breeding area of the beet leafhopper (*Eutettix tenella* Baker) and in such localities the frequent occurrence of curly leaf (curly top or blight) have closed the factories after enormous losses have been sustained. In the San Joaquin Valley four factories were erected in the natural breeding districts of this insect and after the 1919 outbreak of the pest, three of these mills were closed permanently. Since then the sugar mills at Corcoran and Visalia have been dismantled and moved to Preston and Whitney, Idaho.

Investigations have been conducted in the San Joaquin Valley during the past four years and the factors associated with the natural breeding grounds of the leafhopper will be discussed in this paper.

## II. Favorable Breeding Plants of Beet Leafhopper in Cultivated Area

The most noticeable feature in regard to one condition which is favorable for an enormous increase of the leafhopper in the San Joaquin Valley, is the abundance of the host plants upon which this insect feeds and deposits its eggs in the cultivated area. In 1919, we (4) published a paper showing the relative number of beet leafhoppers captured on plants growing in the cultivated area of the San Joaquin Valley and also a list of plants in which eggs were deposited. The plants upon which enormous numbers of nymphs and adults were taken are representatives of the Saltbush Family (*Chenopodiaceae*) to which the sugar beet belongs. The hopper was bred from eggs deposited in 35 species of plants growing under natural conditions in the cultivated area. Later investigations showed, however, that although the females may deposit eggs in certain plants, the nymphs are not able to acquire the winged stage by feeding on these plants. Our breeding experiments also indicate that the most favorable host plants in the cultivated area are the representatives of the *Chenopodiaceae* and closely related families.

Wherever man has injuriously disturbed the natural conditions in the San Joaquin Valley, vast areas of annual saltbushes (*Atriplexes*) occur. These plants, which grow on alkali soil, are commonly found along roadsides and highways. Dense masses of these plants occur along fences. During the autumn and winter, the stalks of the larger species break off near the soil and are rolled along the ground by the wind scattering the seeds. The weeds pile up along barb-wire fences dropping their seeds and this probably explains why certain species of *Atriplex* are so common along fences. Miles and miles of saltbushes grow along railroad tracks. Vacant fields are often covered with thick growths of these alkali plants. Alkali sinks are surrounded by dense masses of this vegetation but often the black alkali is too strong for their development. After the grain is harvested, the stubble fields become covered with *Atriplex*. Hay and straw stacks are commonly surrounded by saltbushes. Irrigation and drainage canals are favorable locations for the development of this alkali vegetation.

What has been the stimulus for the development of enormous areas of annual saltbushes in the San Joaquin Valley? According to Kelly (3) "several hundred thousand acres in the San Joaquin Valley, which were comparatively free from alkali previous to the advent of irrigation,

have already been seriously injured, or abandoned." According to this same writer, alkali finds its way into good lands by the use of saline irrigation water, and by the rise of the ground water level through seepage and over-irrigation.

Among the *Chenopodiaceae* the saltbushes are most favorable for the enormous increase of the beet leafhopper. The following list of Atriplexes found in the San Joaquin Valley, shows whether the different species are native to this country, restricted to California or introduced from other countries:

LIST OF SALTBUSHES FOUND IN SAN JOAQUIN VALLEY

Annuals

1. Silverscale or Fog Weed (*Atriplex expansa*). Native.
2. Bractscale (*Atriplex bracteosa*). Native.
3. Redscale or Red Orache (*Atriplex rosea*). Introduced from Europe.
4. Crownscale (*Atriplex coronata*). Restricted to California.
5. Heartscale (*Atriplex cordulata*). Restricted to California.
6. Arrowscale (*Atriplex phyllostegia*). Native.
7. *Atriplex parishi*. Restricted to California.
8. Spearscale (*Atriplex patula*). Native.
9. *Atriplex tularensis*. Restricted to San Joaquin Valley.

Perennials

10. *Atriplex fruticulosa*. Restricted to Sacramento and San Joaquin Valleys.
11. Australian Saltbush (*Atriplex semibaccata*). Introduced from Australia.
12. Allscale or Cattle Spinach (*Atriplex polycarpa*). Native.
13. Lenscale or Quail Brush (*Atriplex lentiformis*). Native.
14. *Atriplex spinifera*. Restricted to San Joaquin Valley.

In a dry autumn, when no green pasture vegetation occurs on the plains and foothills, the shrubby, perennial Atriplexes serve as food plants for the winter brood which returns to the plains and foothills during October and November. After the pasture vegetation germinates, the adults leave the perennial Atriplexes, feed and deposit their eggs mainly on *Alfilarie* or Red Stem Filaree (*Erodium cicutarium*). In a normal season of rainfall, however, the winter generation feeds on Red Stem Filaree directly, and no large numbers of adults are found on the shrubby, perennial Atriplexes during the autumn. The hopper has been bred, however, from one shrubby, perennial saltbush, *Atriplex spinifera*, under natural conditions, the eggs probably being deposited in the leaves.

The beet leafhopper has been bred from four pigweeds growing in the cultivated area of the San Joaquin Valley. Among the following pigweeds, the Nettle-Leaf Goosefoot (*C. murale*) is the most favorable breeding plant: Pigweed or Lambs Quarters (*Chenopodium album*),

common European weed; Nettle Leaf Goosefoot (*Chenopodium murale*), naturalized from Europe; Mexican Tea (*Chenopodium ambrosioides*), naturalized from tropical America; *Chenopodium leptophyllum*, native.

Another favorable host plant belonging to the *Chenopodiaceae* is the Russian Thistle (*Salsola kali tenuifolia*). This obnoxious weed is a native of Asia and first appeared near Bakersfield in 1895, and is abundant and highly pernicious in many parts of the San Joaquin Valley. Enormous hordes of leafhoppers develop on this plant in the middle and southern parts of the valley.

The beet leafhopper has been bred from one other host plant (*Nitrophila occidentalis*) belonging to the *Chenopodiaceae*, and both nymphs and adults are commonly found on this plant in the San Joaquin Valley. It is found on moist alkali soils, often on black alkali in California, Nevada and Oregon.

A plant from which the beet leafhopper has been bred and upon which large numbers of nymphs and adults are commonly taken in the field is the Lowland Purslane (*Sesuvium sessile*) belonging to the Carpet Weed Family (Aizoaceae). This plant is found on river lowlands and alkali fields in the San Joaquin Valley.

## III. Favorable Breeding Plants of Beet Leafhopper on Plains and Foothills

There existed on the plains and hills of California an abundance of grasses, clovers, and wild flowers, until man disturbed the natural conditions. As early as 1773, the Spaniards disturbed the native conditions by introducing sheep which carried in their wool seeds of plants from the Mediterranean basin. An active competition between the native and introduced plants has occurred to such an extent that most of the native species have been greatly diminished. In all probability, the original foothill host plants of the beet leafhopper were encroached upon by the introduced plants. A special adaptation of the leafhopper to *Alfilaree* or Red Stem Filaree (*E. cicutarium*) occurred, which has spread to the barren hillsides and dry plains. Cattle and sheep have overgrazed the preferred introduced forage plants so that these were not permitted to produce seeds abundantly. It is these over-grazed foothills in the semi-arid regions that are the most favorable habitat of this insect. The enormous area which the Red Stem Filaree now covers according to Thornberg (6) in parts of Washington, Idaho and Texas, and the whole of Oregon, California, Nevada, Arizona, New Mexico and Utah furnished an enormous increase in the food supply of this pest, compared with the original, native host plants. It was the disturbance

of the native conditions on the plains and foothills and in the cultivated area that has increased the most favorable food and breeding plants of the leafhopper and hence has increased the opportunities for an enormous multiplication of the pest when climatic conditions are favorable.

## IV. Favorable Habitat of Beet Leafhopper

Investigations conducted on the plains, canyons and foothills after the autumn flights of the beet leafhopper lead to the discovery of the most favorable habitat of this insect in the San Joaquin Valley. A brief account of the observations made during the rainy season of the past three years will be given.

We (4, 5) have published the results of our observations conducted during 1918, on the autumn dispersion of the leafhopper and recorded large numbers of the pest on the plains and foothills of the Coast Range, Tehachapi foothills in the vicinity of Tejon Pass and Sierra Nevada foothills four miles east of Famosa to Bakersfield. The pasture vegetation germinated after the heavy rains which fell on September 11–13, and wherever the Red Stem Filaree was swept with an insect-net the hoppers were captured during October and November. Nymphs were also taken on the plains and foothills; these probably hatched from eggs deposited by the summer brood adults which acquired the winged stage during late summer or early autumn. A trip was taken on December 13, to the Tehachapi mountains which were snow-capped; no leafhoppers were observed on the foothills but 50 specimens were caught in two hours on the plains about five miles north of the foothills. During January no investigations were made but in February and March, a marked reduction of the overwintering forms was observed on the northern foothills and in canyons. A remarkable peculiarity noted in April, was the fact that the pale green adults of the spring brood were rarely captured on the foothills and in canyons in the northern portion of the San Joaquin Valley.

During December large numbers of Jassids were collected on the foothills bounding a canyon (13 miles southwest of Tracy) in the northern part of the San Joaquin Valley and when these were confined in cages in the greenhouse at Berkeley, they died as a result of a fungus disease. The weather bureau records kept by the Spreckels Sugar Company at Manteca showed that the precipitation from September to April was 17.29 inches; 9.98 inches of rain fell from September to December. We (4, 5) have published the fact that heavy rains kill some of the leafhoppers in the cultivated territory.

During the rainy season of 1919–1920, a comparative study of the beet leafhopper was made in Ingram Canyon situated opposite the northern part of the San Joaquin Valley and in Wild Cat Canyon opposite the middle portion of the valley. In both canyons large numbers of adults had congregated on perennials during the autumn dispersion. The pasture vegetation did not germinate until after the heavy rains which fell on December 1–6, and the bugs then left the perennials and were found on the Red Stem Filaree. A reduction in the number of dark overwintering forms occurred in both canyons between our visits on January 15–16 and February 11–13. It was observed that the females displayed no activity until sunset, the flights were exceedingly low over the short Red Stem Filaree and the movement was from the mouth toward the interior of the canyon. Few specimens were captured by sweeping with an insect-net, but by disturbing the Red Stem Filaree with the hand the adults made several small leaps and were often taken with a pipette. During the autumn flights the insects were commonly attracted to the wind-shield of the automobile but in the winter this behavior did not occur. A striking peculiarity was the fact that only a single pale green leafhopper of the spring brood was taken on the floor of Ingram Canyon on April 21. In Wild Cat Canyon 45 first generation adults were captured on the floor of the canyon and foothills from 1 p. m., until sundown on April 19. During the past two years dark overwintering forms were abundant in canyons in the northern part of the San Joaquin Valley but in the spring instead of an increase a marked reduction of the pale green specimens was evident.

The winter months from December to February were warm and dry but cold weather and heavy rains prevailed during March. The precipitation from September to February at Manteca was 3.96 inches, and a total of 9.19 inches for the season. No fungus diseases developed with any of the Jassids collected.

During the winter and spring of 1920–1921, it was again found that the dark overwintering adults were more abundant than the spring brood in Hospital Canyon (12 miles south of Tracy) situated in the northern part of the San Joaquin Valley. A comparison was made of the number of first brood adults captured on the hillsides in the lower and middle sections of the valley. Sweepings were made on the sunny slopes of Hospital Canyon at intervals of 100 feet to the summit at an elevation of about 1,000 feet, and an average of two adults to 50 sweeps of the insect-net were captured. The number of first brood specimens taken on the Panoche hillsides located in the middle portion of the valley, however, varied from 4–61 in the same number of sweeps.

LITTLE PANOCHE VALLEY.—An examination was now made of the mountain passes and a remarkable discovery was made on April 20, 1920. Hundreds and hundreds of pale green leafhoppers were swarming at sunset on Red Stem Filaree on April 24, in Little Panoche Valley into which the entrance of Panoche Pass opens from the middle section of the San Joaquin Valley. During the calm evening on April 28, the adults were common in the air at dusk; the hoppers assembled on the automobile and mating was observed. The flight of the insects could not be followed to any great distance on account of the approaching darkness, but they flitted about everywhere. Investigations were made from the mouth of Little Panoche Valley following the river benches of Little Panoche Creek via Mercey Hot Springs to the summit, a distance of 12 miles, and swarms of pale green specimens flew about at sunset when the pasture vegetation was swept with an insect-net. Enormous numbers of spring brood forms were found in Little Panoche Valley to the foot of Ortigalita Peak.

PANOCHE VALLEY.—Investigations were conducted in Panoche Valley, situated between the two Coast Ranges, but the bugs were not abundant on Red Stem Filaree growing in the cultivated fields. When the hills are covered with shrubs and trees, as is the case on the second interior Coast Range, beet leafhoppers are very rarely captured on Red Stem Filaree.

PANOCHE HILLS.—During 1920-1921, the investigations were extended to the Panoche Hills bounding the San Joaquin Valley. The dark overwintering adults were common on the Panoche Hills but specimens were rarely taken on the Griswold Hills not bounding the San Joaquin Valley and to the south of the Panoche Hills. During the winter the insects were most abundant on the sunny slopes of the hills.

A trip encircling the Panoche Hills was taken; nymphs and an occasional spring brood adult were taken on the hillsides along Little Panoche Creek as early as March 17. Nymphs and first brood adults were more abundant on the hillsides along Big Panoche Creek, situated about 10 miles southeast of Little Panoche Creek, indicating an earlier development. It was evident that a marked reduction of the overwintering females had occurred due to the fact that they were at the end of their natural life, having deposited their eggs and died.

An interesting observation was made during April. Large numbers of pale green adults were found on the sunny slopes of the Panoche Hills on April 6 where the dark overwintering forms were found during the winter. As the Red Stem Filaree became dry on the hillsides a movement up to the crest of the hills and down to the floor of the canyons

occurred. When the pasture vegetation became dry on the hilltops and floor of Little Panoche Valley, the nymphs and adults assembled on Filaree growing in the drainage furrows and when this food supply became dry the hoppers congregated on annual and perennial plants. MOUNTAIN PASSES.—An examination was made of other mountain passes but up to the present time no enormous assemblage of beet leafhoppers has been found. In Pacheco Pass, about 28 miles north of Little Panoche Valley, the Red Stem Filaree was tall and dense. Spring brood leafhoppers are rarely taken in tall pasture vegetation. In the Coalinga-King City Pass, situated about 50 miles south of Little Panoche Valley the Red Stem Filaree was short and resembled somewhat the condition on the Panoche Hills, but no large congregation of hoppers were found. In the Altamont Pass, about 80 miles north of Little Panoche Valley, the spring brood adults were rarely taken.

It is evident that in canyons and mountain passes of the northern part of the San Joaquin Valley, there are limiting factors which check the multiplication of the beet leafhopper. We have no evidence to show whether the eggs failed to hatch or the recently hatched nymphs succumbed on the foothills. At Manteca eggs deposited in the foliage of sugar beets from November 1 to January 15, 1919 failed to hatch out-of-doors. During the winter a high mortality of the nymphs occurred which hatched from eggs deposited during September and October.

The character of the Red Stem Filaree may be an indicator of favorable Eutettix foothill breeding grounds, but nevertheless, there may be composite controlling factors which hold this insect in check in *some* of the canyons and mountain passes of the northern part of the San Joaquin Valley. Cold winds and fogs sweeping from San Francisco Bay through the Altamont Pass, extending east and west through the Coast Range may be a critical factor in reducing the number of recently hatched nymphs. Cloudiness, rainfall, wet soil and dense pasture vegetation may be other related factors affecting the recently hatched nymphs. In years with an abundance of rainfall, fungus diseases may reduce the number of dark overwintering forms.

Let us now compare some of the apparently favorable factors of the beet leafhopper on the Panoche Hills. Little Panoche Creek flows south for about six miles from the summit of the Coast Range and then meanders southwest for another six miles to the entrance of the mounttain pass. It is evident that the slope exposure in Little Panoche Valley is far more favorable than in a mountain pass extending east and west through the Coast Range and with a break in the mountain range at the coast. Hall (1, 2) has determined mathematically that "the

amount of heat received by a slope with the most favorable gradient is 1.4 times as great as that received by an equal area of land other conditions being constant." The cold winds and fogs from Monterey Bay sweep up the Salinas Valley but on hot days the ocean breeze is very marked on the summit of the interior hills of Little Panoche Valley. No weather bureau records are available as to the precipitation in the Panoche Hills but at Mendota near the valley trough the average rainfall is 6.29 inches; the total amount for the driest year (1897) was 3.79 inches and for the wettest year (1906) was 10.48 inches. The character of the days from sunrise to sunset during the spring is different from the northren part of the San Joaquin Valley, there being fewer cloudy or part cloudy days. The middle portion of the San Joaquin Valley has a higher percentage of sunshine than the northern section of the valley. No further discussion is necessary with reference to the foothill pasture vegetation. It is evident that the vegetation, rainfall, humidity of the air, cloudiness, temperature and possibly other factors may play an important role as to the relative abundance of the beet leafhopper in certain parts of a natural breeding area.

Is there any danger of the beet leafhopper becoming a serious pest in the future in localities where the favorable host plants are absent or do not occur abundantly? As more alkali lands are placed under cultivation in the arid and semi-arid regions, and the alkali salts are brought to the surface, the Atriplexes and other alkali loving plants will increase, offering opportunities for enormous multiplication of the insect. The Red Stem Filaree may spread to the foothills in localities of the western states where it does not occur, furnishing a favorable host plant for the first brood. Although this migratory leafhopper may encounter favorable host plants, nevertheless, climatic barriers may prevent the establishment of the pest.

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Mr. L. O. Howard, Entomologist, Bureau of Entomology, United States Department of Agriculture, Washington, D. C., was present and responded to a request by Mr. Lovett to give an informal talk at this time.

## INFORMAL TALK GIVEN BY MR. L. O. HOWARD, THURSDAY MORNING, JUNE 22, 1922.

Mr. Chairman, you are very courteous to call on me. I am totally unprepared to say anything except to express my pleasure at being present. I have long wanted to be present at one of the Western meetings but it so happened that I have been unable to attend before.

The economic entomologist, wherever he may be, must be tremendously gratified by the great benefit which our branch of the science in the world at large has been. We are getting better contact with other fields of science and they realize that we are working in a scientific way. Economic entomology is thoroughly scientific and it is not a branch of Zoology. I was in communication with a man who said that he was more of a scientific man than all of those fellows at the museum. I do not mean to under-estimate the work of the men of the museum. I am glad that we are going to convene with their meeting. I believe that all entomology is economic entomology, however, and before we get through with this thing we are going to know everything about every single insect. There is considerable very fine work being done by the men in the laboratories. I wish, however, that the laboratories would devote more time to a group that has more practical importance than the individual insect. All these men are doing work that is of economic value. I would like to say for the encouragement of the museum men—I see Mr. Van Duzee over there, one of the museum taxonomists, Mr. Hagan, said that he was afraid that the economic men were getting ahead of the Taxonomists. I believe that they should work along with the economic men and that their work should be encouraged in every way. A new weevil entering sweet potato fields in Mississippi put in an appearance. Now all the economic men knew what this weevil was but they did not know whether they could expect to cultivate a crop or not until we had sent it to the National Museum and had it examined. To our regret we found that it was a characteristic weevil from the region of Chili and Peru. We were able to find out more about it after we got its name and it has been doing considerable work in Australia. If we did not have these taxonomic experiences, we would not have had the benefit of the work in Australia. I will again state, however, that I consider all entomologists economic entomologists.

Some of them may object to being called this but they are just the same.

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Mr. Lovett asked if there were any papers which were missed and called for these if there were any as this could have occurred since the Secretary could not be present and the program was arranged late. There were no outstanding papers to be read.

Mr. Edgar M. Ledyard announced that his office was 904 Newhouse Building and that he would be very glad to extend any courtesies possible to members and hoped that they would call upon him at any time if their movements around the country could be facilitated or if they wanted to get in touch with collecting areas or infested areas, or if they wished to establish financial connections.

The matter of meeting at 2 P. M., then adjourning to meet with the Pacific Coast Entomological Society and the Entomological Society of America as per motion duly seconded and carried, was discussed and Mr. Ledyard was requested to put a notice on the door of Room 44 of the Industrial Building to this effect.

At 11:55 A. M., it was moved, seconded and carried that since there was no more business to come before the meeting at this time the meeting be adjourned in order that there might be time for visiting.

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## NICOTINE DELIVERY FROM DUST CARRIERS[1]

By WILLEM RUDOLFS, Ph.D., *Biochemist N. J. Agricultural Eperiment Stations*

During a study of nicotine dusts the problem to improve nicotine delivery from dust carriers appeared to be essentially of a chemical nature with some physical factors involved. A number of analysed clays were impregnated with definite amounts of nicotine sulfate and the evolution of nicotine from the impregnated dusts determined by drawing a stream of air conditioned to 80° F and 73.6 per cent relative humidity through the dust at a rate of one liter in 10 minutes.

The results showed a great difference from the different dusts, ranging from 0.35 per cent nicotine evolution in 48 hours to 16.15 per cent. In comparing the results of nicotine delivery from clay carriers with the free acidity of the clays no close correlation could be observed, but if the amounts of calcium and magnesium oxids together with the hydrogen-ion concentrations of the clays was compared with the nicotine evolution a more apparent correlation was noticed. An examination of the absorption, water-holding capacity and flocculation data of the clays together

[1]Paper No. 99 Journal Series, Department of Entomology, N. J. Agricultural Experiment Station.

with the chemical results and the nicotine delivery, emphasized the fact that the physical conditions of the clays played a role. For the study of partial inhibition of the nicotine delivery by the colloidal condition of the clays pure silica was mixed with different amounts of a given clay, and the mixtures impregnated with nicotine sulfate. The results seemed to indicate that the nicotine evolution from carriers mixed with nicotine sulfate is mainly a chemical phenomenon.

Pure silica was thereupon thoroughly mixed with representative chemicals in a ball mill and afterwards impregnated with nicotine sulfate at a basis of 2 per cent nicotine. Some of the results obtained are given in table 1.

TABLE 1. EVOLUTION OF NICOTINE FROM SILICA MIXED WITH CHEMICAL ACTIVATORS, IMPREGNATED WITH 2 PER CENT NICOTINE IN THE FORM OF NICOTINE SULPHATE.

| No. | Carrier | | | Percent nicotine after 48 hours. |
|---|---|---|---|---|
| 30 | Silica | +10 % | CaO | 18.29 |
| 31 | " | +2% | $NaNO_3$ | 12.82 |
| 34 | " | +2% | $Na_2CO_3$ | 24.52 |
| 36 | " | +10% | $CaSO_4$ | 11.03 |
| 37 | " | +2% | $CaCl_2$ | 1.60 |
| 38 | " | +2% | $NH_4Cl$ | 3.53 |
| 39 | " | +7.5% | $CaCO_3$ | 26.30 |
| 40 | " | +1% | NaOH | 2.16 |
| 47 | " | +10% | $Ca(OH)_2$ | 5.40 |

The data in the tables are in all instances relative and therefore can be used only for a comparison of the relative nicotine evolution from the dusts under certain definite conditions, as moisture, temperature, air velocity and amount of carrier.

An examination of the data in table 1 shows that the carbonates most readily react with the nicotine sulfate. Calcium carbonate and Magnesium carbonate separately gave better results than any of the other activators used, but a mixture of $CaCO_3$ and $MgCO_3$ proved to be best, Magnesium seemingly acting as a catalyser. Such a mixture was found in the form of dolomite (Magnesium limestone). Dolomite evolved after 48 hours 31.7 per cent nicotine. The reaction between the nicotine sulfate, taking the place of a weak acid, and the carbonates, is probably through replacement of the sulfate radicle by the carbonate radicle and a subsequent volitalisation of the nicotine. Determinations made of soluble and insoluble sulfates before and after the subjection of the mixtures to a stream of air showed a decided increase in insoluble sulfates ($CaSO_4$).

It is apparent that under these conditions the influence of moisture upon the evolution of nicotine from carriers must be considerable. The data given in table 2 indicates conclusively the importance of moisture.

TABLE 2. INFLUENCE OF MOISTURE UPON THE EVOLUTION OF NICOTINE FROM CARRIERS IMPREGNATED WITH NICOTINE SULFATE.

| No. | Carrier | Percent moisture in stream of air | Percent nicotine after 48 hours | Percent nicotine after 120 hours |
|---|---|---|---|---|
| A | Dolomite | 73.4 | 31.68 | 66.32 |
| B | " | 37.0 | 26.18 | 47.75 |
| C | " | dry | 15.27 | 32.77 |
| D | Sea Sand | 73.4 | 6.52 | 12.28 |
| E | " " | 37.0 | 8.97 | 13.68 |
| F | " " | dry | 21.41 | 32.20 |

The fact that approximately the same amount of nicotine evolved from dry sea sand and dry dolomite after 120 hours may be the reason why in arid regions the character of the carrier has not such a great influence as in the Eastern part of the United States. It is interesting to note that the nicotine evolution from sea sand impregnated with nicotine sulfate is inverse to the moisture conditions of this carrier as compared with the moisture conditions of the dolomite carrier impregnated with nicotine sulfate. These data seem to furnish additional proof that surface phenomena play an important role. Theoretically, the chemical reaction should take place at a greater speed when a stream of air is charged with moisture to approximate saturation, but the nicotine evolved seems to be reabsorbed by the precipitating moisture or the moisture present in the dust and less nicotine was set free than with air of a relative humidity of 73 per cent. Temperature also has a decided influence upon the nicotine evolution of nicotine sulfate dusts.

Since the moisture content of the nicotine sulfate solutions (40 per cent nicotine) cannot be reduced without serious difficulties in the manufacturing process, experiments were undertaken with so called "free" nicotine solution, analysing approximately 96 per cent nicotine. Some of the most significant figures secured under similar conditions are:

| | Percent nicotine after 48 hours | Percent nicotine after 120 hours |
|---|---|---|
| Sea Sand | 22.80 | 49.26 |
| Dolomite | 24.78 | 52.48 |

It could be expected that only slight differences should occur since little reaction could take place between the weakly acid liquid, charged with "free" nicotine, and the carriers. The continuous air current together with the relative high temperature drive off the "free" nicotine as a gas from the carriers or absorbents. None or very little chemical reaction takes place between the carriers and the "free" nicotine solution. The following results, reporting the influence of moisture upon the evolution of nicotine from carriers impregnated with "free" nicotine solution, show this clearly:

| | Percent moisture in stream of air | Percent nicotine after 48 hours |
|---|---|---|
| Sea Sand | 73.0 | 22.81 |
| " " | 1.0 | 41.70 |
| Dolomite | 73.0 | 24.78 |
| " | 1.0 | 35.58 |

Sea Sand is a poorer absorbent than dolomite and releases more nicotine with an approximately dry air stream than dolomite. The wetting of the sand causes a film of moisture to cling to the particles and a part of the moisture is easily evaporated by the air, while some of the liquid may be absorbed or has greater adhesion in the case of dolomite.

Sand is too heavy to be used for practical purposes for a considerable force is necessary to blow it for sufficient distribution. For dusting ground crops Magnesium limestone seems a good carrier, is cheap and convenient, does not burn the plants and has a good adhering quality; it can be used to advantage with nicotine sulfate and "free" nicotine. For orchard dusting a light fluffy carrier is needed. In the case of "free" nicotine liquid ordinary hydrated lime can be used and with nicotine sulfate hydrate of lime with 10 per cent dolomite which gives about as good nicotine delivery as dolomite alone.

## Conclusions

I. Nicotine derived from nicotine sulfate:
   1. Is evolved less rapidly from a colloidal than from a crystalloidal carrier.
   2. Is evolved most readily when a large percentage of carbonates (Ca and Mg) is present.
   3. Is evolved more readily under influence of high temperature and high atmospheric moisture conditions.

II. Nicotine derived from high strength (95%) "free" nicotine solution:
   1. Is evolved more readily from a crystalloidal than from a colloidal carrier.
   2. Is evolved from dolomite, hydrated lime, etc. at approximately the same rate.
   3. Is evolved more rapidly under high temperature and low atmospheric conditions.
   4. Is evolved much more rapidly under high temperature and low atmospheric conditions than from nicotine in the sulfate form.

# IS THE HOUSE-FLY IN ITS NATURAL ENVIRONMENT ATTRACTED TO CARBON DIOXIDE?

By CHARLES H. RICHARDSON and EVA H. RICHARDSON

Several years ago, experiments with ammonium carbonate and certain other compounds were reported [1,2] which indicate that the female house-fly (*Musca domestica* L.) is attracted to fermenting organic substances largely by the odor of ammonia. These experiments were conducted in the open in places habitually frequented by house-flies. All indications pointed to the fact that the oviposition responses of these flies were normal. Since then, Crumb and Lyon [3,4] using a somewhat different method have concluded that carbon dioxide induces the house-fly to oviposit in fermenting substances, but that ammonia does not possess this attracting influence. The authors carried out their experiments in a large wire cage in which the reactions of flies that had previously been captured in traps were observed. Furthermore, bran was employed as the nidus, a substance not used in our work referred to above. In view of these differences, it seemed desirable to test the attractiveness of carbon dioxide with bran as a nidus under outdoor conditions. In addition, the attractiveness of bran containing ammonium carbonate was investigated, a combination which as Baumberger[5] has already shown will induce egg-laying. The experiments described below were made at Clarendon Virginia from July 13 till August 18, 1922.

The location selected for these experiments was the southwest side of a dwelling house in a place not subject to strong air currents. It was shaded till midday and lightly shaded during a part of the afternoon. One series of experiments was placed in a different location which received more sunlight during the morning and at midday.

The experimental receptacles (funnels or dishes) were placed on a wooden shelf in a linear series 2 feet apart. A shelf below this held the carbon dioxide generators. In each series there were always more carbon dioxide than ammonium carbonate experiments. The position

[1] Richardson, C. H. A chemotropic response of the house-fly (*Musca domestica* L.) Science n. s. 43, 613-6 (1916).

[2] ———— The response of the house-fly (*Musca domestica* L.) to ammonia and other substances. N. J. Agric. Expt. Stations Bull. 292, 19 pp. (1916).

[3] Crumb, S. E. and Lyon, S. C. The effect of certain chemicals upon oviposition in the house-fly (*Musca domestica* L.) J. Econ. Entom. 10, 532-6 (1917).

[4] ———— Further observations on the effect of certain chemicals upon ovipositon in the house-fly (*Musca domestica*) J. Econ. Entom. 14, 461-5 (1921).

[5] Baumberger, J. Percy. A nutritional study of insects, with special reference to microorganisms and their substrata. J. Exptl. Zool. 28, 1-81 (1919).

of the individual experiments was changed daily. The duration of each series of experiments varied from 5 to 11 hours; in nearly every instance it covered the time from 11 A. M., till 4 P. M., when flies were most abundant and active. During showers the receptacles were covered.

Flies were always present but never abundant in this location; 17 was the largest number counted at any time. For this reason, a small number of experiments was run almost daily throughout the period covered by this investigation rather than a large number for a short period of time.

The bran employed was a sterilized commercial product, especially prepared for culinary purposes. It consisted largely of wheat husk. Except in a few instances, it was not sterilized before use. All chemicals were of C. P. grade. Well water was used in all solutions and for other purposes where water was required.

The carbon dioxide used in these experiments was liberated from sodium carbonate by means of sulfuric acid. The acid (specific gravity 1.84) was diluted to 20 percent. by volume before use. A generator consisting of a 400cc. salt-mouth bottle or a milk bottle of pint or quart capacity equipped with a dropping funnel and a glass delivery tube supplied the gas which was conducted through a rubber tube to the experimental receptacle. Forty, 50 or 100 g. of sodium carbonate in 30 to 60cc. water were decomposed by the slow dropwise addition of the dilute acid. The flow was regulated to give a steady evolution of carbon dioxide from 11 A. M., till 4 P. M., or longer. The bran nidus was exposed in the glass funnels or porcelain dishes mentioned above. The funnels were 10.2 cm. in diameter; each held a perforated procelain disk 5 cm. in diameter which prevented the bran from clogging the stem of the funnel. Each funnel contained about 15 g. bran (air dry weight) well moistened just before the experiment started. The generator tube was attached to the stem of the funnel and in this way carbon dioxide was conveyed through the bran and into the air above. The porcelain dishes measured 13.3 cm. in diameter and 2.5 cm. in depth. A piece of absorbent cotton occupied the bottom of each dish to help retain miosture; over this the bran was spread and the glass nozzle of the generator tube was thrust in the center of the bran mass. Water was added to each dish. Further details concerning the carbon dioxide dish experiments are given in table I.

Porcelain dishes were generally used for the ammonium carbonate experiments. Each dish contained a piece of cotton, 10 g. bran (in one case 20 g.) and 25 to 30 g. of solid ammonium carbonate (an equimolecular mixture of ammonium bicarbonate and ammonium

carbonate) or 50cc. of a saturated solution of ammonium carbonate. The solid ammonium carbonate (in lumps) was always covered with a thin layer of bran. Unless ammonium carbonate solution was used from 25 to 50cc. water were added to each dish. The funnel experiments with ammonium carbonate were similar to the carbon dioxide experiments in general arrangement except that a piece of wet cotton covered the porcelain disk over which the bran was spread. The funnels were supported by means of rubber stoppers in bottles which contained water. Other details are given in table II.

The controls contained only bran and water; in arrangement and amounts of these substances they followed closely the other experiments.

The following experiments are selected to illustrate the methods and results obtained.

TABLE 1. CARBON DIOXIDE AND AMMONIUM CARBONATE EXPERIMENTS IN PORCELAIN DISHES

CARBON DIOXIDE EXPERIMENTS: Generators contained 50 g. $Na_2CO_3$ and 30cc. $H_2O$; dropping funnels held 150 cc. 20 volume % $H_2SO_4$; each dish contained a piece of cotton, 10 g. bran moistened with $H_2O$ and 25 to 50 cc. $H_2O$.

AMMONIUM CARBONATE EXPERIMENTS: Each dish contained cotton, 25 to 30 g. solid ammonium carbonate, 10 g. bran moistened with $H_2O$ and 25 to 50 cc. $H_2O$.

CONTROLS: Each dish contained cotton, 10 g. bran moistened with $H_2O$ and 25 to 50 cc. $H_2O$.

| No. | Material | Date | Duration Hrs. | Duration Mins. | Eggs deposited: Egg masses* | Eggs deposited: Single eggs | Total eggs |
|---|---|---|---|---|---|---|---|
| 1, 4 | $CO_2$ | 7-23 | 6 | 45 | 0 | 0 | 0 |
| 2 | Ammonium carbonate | " | " | " | 6 | 0 | 50 |
| 3 | Control | " | " | " | 0 | 0 | 0 |
| 5, 7, 9 | $CO_2$ | 7-24 | 11 | 0 | 0 | 0 | 0 |
| 6 | Control | " | " | " | 0 | 0 | 0 |
| 8 | Ammonium carbonate | " | " | " | 0 | 0 | 0 |
| 10, 12, 14 | $CO_2$ | 7-25 | 8 | 30 | 0 | 0 | 0 |
| 11 | Ammonium carbonate | " | " | " | 4 | 0 | 154 |
| 13 | Control | " | " | " | 0 | 0 | 0 |
| 15 | Control | 7-26 | 9 | 45 | 0 | 0 | 0 |
| 16, 17, 19 | $CO_2$ | " | " | " | 0 | 0 | 0 |
| 18 | Ammonium carbonate | " | " | " | 2 | 0 | 82 |
| 20, 21, 23 | $CO_2$ | 7-27 | 10 | 0 | 0 | 0 | 0 |
| 22 | Control | " | " | " | 0 | 0 | 0 |
| 24 | Ammonium carbonate | " | " | " | 7 | 1 | 126 |
| 25 | Ammonium carbonate | 7-29 | 10 | 20 | 10 | 21 | 330 |
| 26, 28, 29 | $CO_2$ | " | " | " | 0 | 0 | 0 |
| 27 | Control | " | " | " | 0 | 0 | 0 |

*An egg cluster containing 2 or more eggs was considered to be an egg mass.

TABLE 2. CARBON DIOXIDE AND AMMONIUM CARBONATE EXPERIMENTS IN GLASS FUNNELS

CARBON DIOXIDE EXPERIMENTS: Generators contained 100 g. $Na_2CO_3$ and 60 cc. $H_2O$; dropping funnels held 300 cc. 20% acid; each funnel contained 15 g. moistened with $H_2O$.

AMMONIUM CARBONATE EXPERIMENTS: Each funnel contained a piece of cotton, 15 g. bran moistened with $H_2O$ and 25 g. solid ammonium carbonate. The funnels were supported by means of stoppers in 400 cc. bottles containing 300 cc. $H_2O$.

CONTROLS: Each funnel contained 15 g. bran moistened with $H_2O$ and was placed in a 400 cc. bottle which held 300 cc. $H_2O$.

| No. | Material | Date | Duration Hrs. | Duration Mins. | Eggs deposited: Egg masses. | Eggs deposited: Single eggs | Total |
|---|---|---|---|---|---|---|---|
| 30,32 | $CO_2$ | 8-2 | 9 | 35 | 0 | 0 | 0 |
| 31, 33 | Control | " | " | " | 0 | 0 | 0 |
| 34 | Ammonium carbonate | " | " | " | 3 | 0 | 144 |
| 35 | Ammonium carbonate | 8-3 | 9 | 40 | 3 | 0 | 54 |
| 36, 38 | Control | " | " | " | 0 | 0 | 0 |
| 37, 39 | $CO_2$ | " | " | " | 0 | 0 | 0 |
| 40, 44 | $CO_2$ | 8-4 | 5 | 30 | 0 | 0 | 0 |
| 41, 43 | Control | " | " | " | 0 | 0 | 0 |
| 42 | Ammonium carbonate | " | " | " | 0 | 0 | 0 |
| 45 | Ammonium carbonate | 8-5 | " | " | 0 | 0 | 0 |
| 46, 48 | $CO_2$ | " | " | " | 0 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 47, 49 | Control | " | " | " | 0 | 0 | 0 |
| 50, 52 | $CO_2$ | 8-6 | " | " | 0 | 0 | 0 |
| 51 | Ammonium carbonate | " | " | " | 1 | 0 | 52 |
| 53, 54 | Control | " | " | " | 0 | 0 | 0 |
| 55, 59 | Control | 8-7 | " | " | 0 | 0 | 0 |
| 56, 58 | $CO_2$ | " | " | " | 0 | 0 | 0 |
| 57 | Ammonium carbonate | " | " | " | 0 | 0 | 0 |

Fifty-five carbon dioxide, 23 ammonium carbonate and 59 control experiments were completed. Carbon dioxide gave entirely negative results; the same was true of the controls. Fourteen of the ammonium carbonate experiments were positive, yielding 1890 eggs, an average of 135 eggs for the positive experiments and 82.2 eggs for the entire 23 experiments. There were 62 egg masses and 26 single eggs or an average of 4.4 masses and 1.9 single eggs for the successful experiments. In view of the small number of flies present, oviposition in 61 percent, of the ammonium carbonate experiments is considered significant. It is believed that stormy and cool weather tended to prevent oviposition on certain days.

House-flies often crawled over and fed upon the moist bran in both the carbon dioxide and control experiments. However, the preoviposition behavior of backing into crevices and extruding the ovipositor, so often manifested on bran containing ammonium carbonate, was never observed in the carbon dioxide or control experiments. We therefore conclude that the house-fly in its natural environment will not oviposit on bran from which carbon dioxide alone arises. Nor will it, under the conditions here set forth, oviposit in bran within 11 hours after it has been moistened with water. Bran, on the other hand, which evolves the final decomposition products of ammonium carbonate, e.g., ammonia, carbon dioxide, and water, will attract the house-fly and induce oviposition. Water is probably essential to induce oviposition; however, since water was common to all experiments it could hardly have influenced the choice. Carbon dioxide itself was ineffective. By elimination, then, only ammonia remains and we do not possess sufficient evidence to justify a revision of the former conclusion,[1, 2] namely, that ammonia is largely responsible for the attraction of the house-fly to fermenting organic substances. The possible attractive influence of carbon dioxide in mixtures of ammonia, water vapor and air must be admitted, although this influence is probably an augmenting rather than a determining one. The presence in the air of undissociated molecules of ammonium carbonate, even in small amounts, may also have an effect which was not detected.

Ammonium hydroxide solutions were used in 36 experiments of a preliminary character. Concentrations of 2, 5, 7, 10, and 14 percent. ammonia were made up from ammonium hydroxide containing 28

percent. ammonia. Porcelain dishes containing cotton, 10 g. bran and 50 cc. of the ammonium hydroxide solution were usually employed. On July 31, 8 eggs were found in a dish to which 50cc. of a solution containing 2 percent. ammonia had been added, and on August 5, 390 eggs were counted in a dish which held the same amount of a solution containing 14 percent. ammonia. Time did not permit a more thorough investigation of this subject, but we hope to return to it in the future. The partial success with ammonia noted here and in previous experiments[1,2] together with the negative results obtained with carbon dioxide again lead to the conclusion that the female house-fly is attracted largely by the odor of ammonia.

Aqueous solutions of ammonium carbonate and ammonium hydroxide differ in a number of particulars which may account for this difference in attraction. With solutions of equal percentage concentration of ammonia, ammonium carbonate solution evolves ammonia much more evenly than a solution of ammonium hydroxide. An ammonium hydroxide solution gives off a large part of its ammonia during the first 2 or 3 hours of exposure, while an ammonium carbonate solution evolves about one-third as much. The ammonium hydroxide solution will also have a higher concentration of hydroxyl ion. These and other differences may account for the greater attraction of an ammonium carbonate solution.

The results described by Crumb and Lyon represent, we believe, the anomalous responses of house-flies reacting in an unnatural environment.

It may be of interest to state in passing that *Stomoxys calcitrans* L. was seen almost daily in the vicinity of these experiments but never alighted on the bran. It is apparently not attracted to the compounds used in this investigation.

## Conclusions

1. Bran which volatilizes carbon dioxide alone when exposed in the natural environment of the house-fly will not induce oviposition.

2. Bran which volatilizes the products of decomposition of ammonoium carbonate in aqueous solution attracts the house-fly and induces egg-laying.

3. Since carbon dioxide and water, two of the final decomposition products of ammonium carbonate, do not in themselves induce egg-laying, it is believed that ammonia is largely responsible for the attraction to ammonium carbonate.

4. The possibility of other substances exerting an augmenting influence on the attraction to ammonia is admitted, but no definite proof of it was indicated in these experiments.

5. Some preliminary experiments with ammonium hydroxide solutions were only partially successful in calling forth the oviposition response. Some possible reasons for this are mentioned.

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# THE ABILITY OF QUEEN AND DRONE HONEYBEES TO FEED THEMSELVES

By E. F. Phillips, *Bureau of Entomology*

In connection with some feeding experiments with worker bees to determine the digestibility of various carbohydrates, it seemed of interest to learn to what extent queens and drones are able to take food without the help of worker bees. It has generally been assumed that both queens and drones are regularly fed by the workers, and it is even sometimes believed they will starve in the midst of plenty unless they are so fed. Several observers have, however, mentioned seeing drones and queens taking food direct. In the killing of the drones at the close of the honey-flow, it is usually assumed that they are first starved by a failure of the workers to feed them and that after such treatment they are easily carried or driven from the hive.

During the morning of May 19, 1922, a colony of bees was removed to a new stand while the bees were flying freely, permitting the old field worker bees and flying drones to return to an empty hive on the old stand. A short time later the bees remaining in the original hive were shaken from their combs and allowed to return to them through a queen-excluder, thus removing the drones and causing the remaining old bees to fly so that more of them would return to the original location, it being desirable to remove both the drones and the old worker bees for projected experiments. As there was free access for the worker bees into the super containing the drones, a few remained with the drones. In the early afternoon two small wire-cloth and wood cages were filled with drones, and in both cases a few workers went with them, as will be indicated.

The cages containing the drones were placed in a dark room in the basement of the laboratory. The temperature of the room, taken daily at the time the dead drones were removed and counted, is given in the accompanying table. The temperature of this room is quite constant. The room was lighted only during the removal of the dead bees, they being taken outside for counting and the room darkened. In the same room were worker bees under similar experiments and these also were removed daily as they died. Probably the total time that the room was lighted while drones were still living never exceeded an hour daily.

The temporary lighting of the room caused both the drones and worker bees to become more active, and this in turn perhaps shortened the length of life to a small degree.

(1) *Drones without food*:—A cage containing 170 drones and 3 worker bees was placed in the dark room, and was provided with a bottle containing water, but the bees were given no food. One worker died the first day and the other two died the second day. The death rate of the drones is shown in the accompanying table. The average length of life of these drones was $2.5294 \pm 0.0499$ days. The last drone died on the fifth day. ($\sigma = 0.9652 \pm 0.0353$; $C = 38.16$).

(2) *Drones with cane sugar solution*:—A cage containing 144 drones and two worker bees was placed in the room at the same time. These were given a bottle feeder containing a saturated solution of cane sugar (sucrose C.P.). One worker died on the second day and the other on the fourth day. The death rate of the drones is shown in the accompanying table. The average length of life of the drones was $4.9722 \pm 0.1176$ days. The last drone died on the tenth day. ($\sigma = 2.0915 \pm 0.0831$; $C = 42.06$).

It is quite evident from the figures given that drones are able to take food from a bottle feeder, since the average length of life is double, within the limits of the probable errors, in the case of the drones provided with food. Since the last drone in those fed lived six days after the last worker died, there can be no question as to the possibility that the two workers in this cage fed all the drones. The condition of the living drones in the two cages was quite different also. Those without food were exceedingly sluggish at the end of the first day, while in the cage where food was provided they were quite active until almost all of them were dead. This difference which was quite evident during the experiment can not be expressed in figures.

To determine whether queenbees are also able to feed themselves, the following experiments were tried. One queenbee (No. 2) was placed alone in a small introducing cage at 11:00 A. M. on June 24. On top of this cage there was placed a small bottle feeder containing a solution of cane sugar (sucrose C.P.), saturated at room temperature (then 24.6° C.). This queen lived until 1:30 P.M. July 4, the temperature of the laboratory room during the interval being quite high. On the same date a queen (No. 1) was placed in a similar cage with nothing given except water and she was dead the following morning at 9:00 A.M. On June 29 at 2:00 P.M. another queen (No. 3) was placed in a similar cage with water only and she was found dead at 7:00 A.M. the following morning. On June 29 at 2:00 P.M. another queen (No. 4) was placed in a cage with water

only and she was found dead at 3:00 P.M. on July 1, she having been observed moving feebly at 1:00 P.M. From this one instance of the queen living ten days with food, compared with the three checks without food, it is quite evident that this queenbee was able to take food from a bottle feeder and to nourish herself. It is quite frequently observed in mailing queens that on arrival the queen will be the only individual alive, this also indicating that she is able to take food alone.

For purposes of comparison, it may be stated that at the time the drones were experimented upon a cage containing worker bees and fed cane sugar was found to live an average of 9.175±0.1291 days, the last worker dying on the 19th day. The detailed data for this feeding experiment will be used later for another purpose and is not here recorded in full.

TABLE SHOWING DEATH RATE OF DRONES

| Day | Drones dead without food | Drones dead, sugar syrup | Temperature |
|---|---|---|---|
| 1 | 16 | 2 | 19.2 |
| 2 | 84 | 12 | 19.8 |
| 3 | 40 | 34 | 19.4 |
| 4 | 24 | 22 | 20.6 |
| 5 | 6 | 13 | 19.8 |
| 6 | | 18 | 19.2 |
| 7 | | 22 | 21.5 |
| 8 | | 17 | 19.6 |
| 9 | | 3 | 17.2 |
| 10 | | 1 | 19.4 |
| Totals | 170 | 144 | |

## Scientific Notes

**A Rice Leaf-Miner.** Parts of California's rice growing districts have suffered this year from the attack of a leaf-miner identified as *Hydrellia scapularis* Loew. The flies pupated in the leaves and emerged during the last two weeks of June. One brood alone was noticed attacking in June at which time the rice was 6 to 12 inches high. The attacked leaves turned brown and lay flat on the water as if the plant were dead but after a few days of warm weather the greater portion of those affected sprouted. The attack will delay harvest which gives rise to greater danger from early rains interferring with the harvest. The injury was most noticeable in checks that were carrying an unusual depth of water, which was used to drown water grass. The seriousness of the attack was due to the weakening effect of too great a depth of water coupled with the leaf-miner injury.

E. R. DE ONG,
*University of California.*

**Ocnerostoma piniariella Zeller, Anther Introduced Insect.** Specimens of western white pine needles mined by this insect were received under date of June 29, 1922

accompanied by the statement that the material was collected in British Columbia at Hilltont's, near Abbotsford, and that the larva appears to mine one needle of the whorl and then forsakes its gallery and spins a slight cocoon between the needles, the adult issuing the latter part of July as evidenced by the forwarding of moths by Doctor J. S. Boyce, July 21st. The general character of the work is suggestive of our native pine leaf miner, *Paralechia pinifoliella* Chambs., except that this insect pupates in a loose cocoon constructed on the outside of the needles. We are informed by Doctor August Busck, who kindly determined the species, that the insect has never hitherto been recorded from outside of Europe.

E. P. FELT

**Green Soldier Bug.** *Nezara hilaris* Say, has recently appeared in the role of a destructive peach pest in Davis and adjacent counties, Utah. One orchardist with large holdings has lost heavily twice during the past four years. Specimens taken in this orchard were identified by Dr. E. P. Van Duzee who states that tho the insect is generally distributed throughout the West it has not previously been reported as a pest. In all respects the situation in the orchard above cited seems to be identical with that described by Whitmarsh in the Ohio Agricultural Experiment Station Bulletin No. 310. In a brief article written for the *Utah Farmer* the writer of this note has suggested the burning of all leaves, trash and debris in the orchard among infested trees during the winter, or opening these to the action of the elements. It is further suggested in the absence of accumulations of leaves etc., that small piles of leaves, straw, weeds, dry manure or similar material be provided as inviting hibernating sites late in September and that these be prevented from blowing away by suitable materials such as large weeds or light brush.

WYATT W. JONES

**Effect of Water on Larvae of Bulb Flies.** It has been rumored by Dutch bulb brokers that the narcissus fly and the lesser bulb fly could be controlled by immersing the bulbs in water at room temperature for a period of twenty-four hours.

In order to prove or disprove this rumor, the following experiments were conducted.

1. Seven larvae of the Narcissus Fly (*Merodon equestris* Fab.) were placed in water at room temperature, October 20, 1922.

7 larvae lived 1 day.
3 larvae lived 3 days.
1 larvae lived 4 days.

II. Seven larvae of the lesser bulb fly (*Eumerus strigatus* Fallen) were placed in water at room temperature, October 21, 1922.

7 larvae lived 2 days.
6 larvae lived 3 days.
2 larvae lived 7 days.
1 larvae lived 9 days.

H. L. SANFORD,
*Entomological Inspector,*
*Federal Horticultural Board*

November 3, 1922.

**Eois ptelearia Riley (Geometridae) Detected in the Herbarium of the Carnegie Museum.** The late Professor C. V. Riley in "Insect Life," Vol. IV, 1892, p. 112,

called attention to the ravages of *Eois ptelearia* (Riley) in the Herbarium of the United States National Museum, and the late W. G. Wright in the same volume, p. 271, spoke of the insect as feeding upon stored hay.

My attention has just been called by Professor O. E. Jennings, the Curator of the Herbarium of the Carnegie Museum, to the fact that he has discovered that certain material recently collected by him was found to be suffering from the infestation of the same insect. Vigorous steps have been taken to guard against its spread in the Herbarium of the Carnegie Museum. Nevertheless it is found to have attacked quite a number of fascicles of plants dried within the last twelve months, and which had not yet been poisoned or permanently placed in the Herbarium. As noted by others, the larvae seem to have a preference for the flowers of the *Compositae*. Today I inspected an unpoisoned bundle of plants, in which the insect was found feeding upon the blossoms of various species of *Bidens*, *Solidago*, and *Eupatorium*. It also had ruined a specimen of *Gentiana* and of *Parnassia*. It feeds greedily upon the berries of *Cornus* and *Smilax*. I have not taken the time to make an inventory of all the species of plants which have been attacked, but it evidently is a very dangerous and almost omnivorous herbarium-pest. We shall succeed, no doubt, in eradicating it, but I beg my botanical friends to take warning. The creature, which was first reported as feeding upon herbarium specimens from the Southwest, seems to have spread as far as Pennsylvania, and great vigilance will be required to guard against its ravages in the future.

*Carnegie Museum*
*Oct., 31, 1922.*

W. J. HOLLAND,
*Director Emeritus.*

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**Gipsy Moth and European Corn Borer.** An important conference called by Commissioner of Farms and Markets, Berne A. Pyrke, was held at Albany, N. Y., Nov. 16. The Federal Government was represented by Drs. L. O. Howard, C. L. Marlatt, E. D. Ball, W. R. Walton, and Messrs. A. F. Burgess, H. L. McIntyre, L. H. Worthley and D. J. Caffrey; the Dominion of Canada by L. S. McLaine of the Inspection Service and J. M. Swaine, Forest Entomologist; the State of New Hampshire by W. A. Osgood; the State of Vermont by Harold A. Bailey in Charge of Insect Suppression; the State of Massachusetts by Dr. A. W. Gilbert, Commissioner of Agriculture, R. H. Allen, Charles O. Bailey of the Conservation Commission and George A. Smith; the State of Rhode Island by Ralph A. Sheals, Assistant Entomologist; the State of Connecticut by Dr. W. E. Britton, State Entomologist; the State of New Jersey by Dr. T. J. Headlee, State Entomologist; the State of New York by C. R. Pettis and W. G. Howard of the Conservation Commission; Commissioners Pyrke and Hogue, Dr. G. G. Atwood and B. D. VanBuren of the Department of Farms and Markets; Prof. P. J. Parrott of the Geneva Experiment Station; Prof. G. W. Herrick of the State College of Agriculture and Dr. E. P. Felt and D. B. Young of the State Museum. The N. Y. State Forestry Association was represented by its secretary, J. R. Simmons. The broader phases of the problems in relation to these two insects were discussed and substantial agreement reached in regard to a general policy. The more important conclusions will be made public in the near future.

# JOURNAL OF ECONOMIC ENTOMOLOGY

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There is in eastern New England a nice illustration of the complexities arising from the indiscriminate introduction of plants and animals. It is well known that a considerable number of our most common and noxious weeds are introduced species. The same is true of insects. The European Corn Borer is one of our newest pests and not content in this county with its presumably preferred food plant, corn, it has turned to weeds and in the succulent growth on abandoned market garden areas in the environs of Boston has multiplied so extensively that in spite of the great destruction of the pests in cultivated plants following ordinary agricultural and market garden practices, there are hosts of moths coming from the weed areas and reinfesting in extreme degree not only the favorite food plant, corn, but the insects, apparently driven by scarcity of available material, are breeding upon other garden crops, such as celery, spinach and beets and herbaceous ornamentals, particularly dahlias, chrysanthemums and asters. The weeds, while seriously infested, reproduce abundantly and appear to add greatly to an infestation which might otherwise be only moderately injurious.

## Current Notes

Mr. Lachlan Gibbs, a British entomologist, died in London, England, March 1, 1922.

Mr. Frank J. Rimoldi, Cornell 1916, is teaching entomology this year at the University of California.

Mr. W. R. Walton of the U. S. Bureau of Entomology spent a day at the Fredericton, N. B., Laboratory recently.

According to *Science*, the entomological laboratory and offices of the Station Agronomique de la Guadeloupe were recently destroyed by fire.

Prof. W. H. Brittain of the Nova Scotia Agricultural College spent a day recently at the Japanese Beetle Laboratory, Riverton, N. J.

Mr. Lawrence Reynolds, an entomologist and collector in Central and South America, died recently in Boston at the age of forty-four years.

A new building at the University of Missouri for which the last legislature appropriated $200,000.00 will contain a room for the entomological collections.

Mr. John B. Gill, Bureau of Entomology, attended the annual convention of the National Pecan Grower's Association, at Thomasville, Ga., October 3–5, 1922.

Recent visitors at the Federal Fruit Insect Laboratory at Sandusky, Ohio, include A. F. Burgess and Dr. A. C. Baker of the Bureau of Entomology.

Prof. H. A. Gossard during his vacation in October visited Florida, and expected to attend the annual meeting of the National Nut Grower's Association.

According to *Science*, Mr. Francis Maidl of the National Museum of Vienna, has been appointed curator of the department of entomology at Cornell University.

Mr. C. B. Nickels has been transferred from the position of field entomologist to that of research entomologist at the South Carolina Agricultural Experiment Station.

According to *Science*, Mr. John L. Buys, instructor in entomology at Cornell University, has been appointed assistant professor of entomology at the University of Akron.

Mr. E. P. Ide, temporary laboratory assistant, Entomological Branch, Ottawa, Canada, during the summer months, has resigned to continue his course of study in the Collegiate Institute.

Dr. C. L. Marlatt, Chairman of the Federal Horticultural Board, returned about October 1, to his official duties at Washington after having spent the summer in Maine.

Mr. W. W. Yothers of the Bureau of Entomology attended the County Agent's meeting held in Gainesville, Fla., September 9–14, where he discussed rust mites and their control.

Mr. W. J. Kostir, for the past year instructor in zoology at Columbia University, returned this fall to Ohio State University as assistant professor of zoology and entomology.

Mr. Dwight M. DeLong received the degree of doctor of philosophy from the Ohio State University last June, and is now assistant professor of entomology at that institution.

The Kansas State Agricultural College has granted Assistant Professor Wm. P. Hayes of the Department of Entomology, a leave of absence for the coming year to study at Cornell University.

An address on peach insects was delivered before the Kiwanis Club of Fort Valley, Georgia, on October 6th, by Mr. Oliver I. Snapp, of the U. S. Bureau of Entomology.

Dr. David Sharp, formerly curator of the Museum of Zoology at the University of Cambridge, and editor of the *Zoological Record*, died August 27, at the age of eighty-one years.

Dr. E. D. Ball is chairman, and Doctors A. L. Quaintance and A. C. Baker are members of the Committee on Preliminary Arrangements for the Graduate School for workers in the U. S. Department of Agriculture.

The following appointments to the Bureau of Entomology are announced: George W. Ellington, Lexington, Miss., July 27, to assist in meat insect investigations; E. A. Vaughn, August 22, grain-insect investigations, Thomasville, Ga.

Dr. E. D. Ball, director of scientific work in the U. S. Department of Agriculture, is national president of Gamma Sigma Delta, the Agricultural honor society. He installed a chapter at the Pennsylvania State College on October 10.

Mr. Maurice E. Phillips, dried fruit insect investigations, Bureau of Entomology, has located his laboratory at 433 Weldon Avenue, Fresno, Calif., and during the past summer has been making a special investigation of the Indian-meal moth.

Messrs. J. A. Harris and H. J. Dodd, field assistants at the Peach Insect Laboratory of the U. S. Bureau of Entomology at Fort Valley, Georgia, have resigned. Mr. Harris has accepted a position with the State Plant Board of Mississippi.

In connection with the investigation of the natural control of the larch sawfly in Canada, it has been found that one of the shrews plays an important part. A live shrew kept in captivity consumed 175 cocoons every twenty-four hours.

Dr. Henry Fox and Prof. W. A. Price of the Japanese Beetle Laboratory force, temporary appointees during the summer, have returned to their collegiate duties. Dr. Fox will return to Mercers University, Macon, Ga., and Prof. Price will return to Purdue University.

According to *Science*, Prof. F. L. Washburn of the University of Minnesota, accompanied by Mr. Cadwallader Washburn, sailed on September 8 for Tahiti and other South Sea islands. Prof. Washburn is on sabbatical leave and will make a collection of insects for the university.

The Entomological Branch arranged an interesting and instructive exhibit of insects and their work for the Canadian National Exhibition held at Toronto, August 28th to September 9th. An exhibit was also arranged for the Central Canada Exhibition held in Ottawa, September 9–18.

Professor Herbert Osborn attended a meeting at Woods Hole, Mass., August 4 and 5, of a committee raised to work out details of a plan for a federation of American Biological Societies. Professor Osborn substituted for Professor B. E. Livingston, and represented the American Association for the Advancement of Science.

According to *Science*, Dr. Charles A. Kofoid, professor of zoology, University of California, was scheduled to lecture on "Animal Foes of the Human Body," October 29, in a course of six free public lectures concerning science and health at the California Academy of Sciences, Golden Gate Park, San Francisco, Cal.

Prof. Dr. Julius Wagner of the newly founded Entomological Institute, Belgrade University, Jugoslavia, Krunska, F. F., A., desires to correspond with entomologists of this country and to receive their publications. He states that in a short time the Agronomic Section of Belgrade University, will begin publication of the work of the Experimental Stations and the Entomological Institute and that he will be pleased to send these in exchange for American literature.

Prof. Edward P. Thompson, Riverside, Calif., died May 19 of pneumonia. He was one of the founders of the Association of Economic Entomologists. A brief account of his part in that historic event is given by Dr. Howard on page 29 of this volume.

*Science* announces the formal retirement of Professor H. E. Summers as professor of zoology at Iowa State College and State Entomologist, a position to which he was

appointed in 1898. He will live in Los Angeles, California. Since his serious illness several years ago, Professor Summers has not been on active duty.

*Entomological News* announces the death of the following entomologists: George A. J. Rothney, England, January 31, 1922; Arthur W. Bacot, Cairo, Egypt, April 12, 1922; Henry Rowland Brown, England, May 3, 1922; Hans Frühstorfer, Munich, Germany, April 9, 1922; Dr. Otto Taschenburg, Halle, Germany, March 20, 1922; Louis Bedel, France, February 8, 1922.

Professor L. M. Peairs, head of the Department of Entomology of the University of West Virginia, visited the Department of Entomology at the Kansas State Agricultural College September 10th to 12th on his return from a vacation trip in California. Professor Peairs received his Master's Degree from the Kansas State Agricultural College in 1907.

Dr. E. D. Ball, director of scientific research, and Dr. L. O. Howard, Chief of the Bureau of Entomology, left Washington, October 12, for a short trip through the south. They were accompanied by Dr. H. A. Morgan, President of the University of Tennessee, and will study various phases of the boll weevil situation in Louisiana and Mississippi.

Recent visitors to the Bureau Laboratory at Fort Valley, Georgia, to observe peach insect investigations under way include Director H. P. Stuckey of the Georgia Experiment Station, Dr. J. J. Skinner, U. S. Bureau of Plant Industry, Agricultural Development Agents of the Railroads of the Southeastern States, and several groups of peach growers from South Carolina, Tennessee and Mississippi.

Dr. J. M. Swaine, Chief of the Division of Forest Insects, Entomological Branch, left Ottawa on August 17th for Saskatchewan and British Columbia to investigate outbreaks of forest insects and to go over the work of the Division in the latter province with Mr. Hopping. On his way west he stopped at the Porcupine Mts. to investigate a large outbreak of *Dendroctonus* on spruce.

Mr. Ernest R. Barber formerly of the Bureau of Entomology is now at the head of the Barber Entomological Laboratories at Canal and Baronne Streets, New Orleans, La., and is engaged in supplying Argentine ant poison prepared after the Government formula recommended in Farmers' Bulletin No. 1101. The Laboratories have made up nearly 140,000 gallons of this ant poison this fall and have supplied nearly 80 southern cities with this product to be used in ant control.

The railroads of the country have prohibited the use of carbon disulphid as a fumigant of grain in their rolling stock except at certain points, particularly at Baltimore and New Orleans. The U. S. Department of Agriculture has been called upon by them to investigate the possibility of finding a fumigant more suitable than carbon disulphid for grain fumigation and the Bureaus of Entomology and Chemistry have been co-operating in this investigation which has now been under way for several months.

A party of entomologists and agricultural commissioners visited the areas near Boston infested by the European corn borer on October 10. According to the newspapers, the following were present: Dr. A. W. Gilbert, Commissioner of Agriculture, Boston, Mass.; Dr. E. P. Felt, State Entomologist, and Dr. George G. Atwood, Director Bureau of Plant Industry, State Department of Agriculture, Albany, N. Y.; Professor W. C. O'Kane, State Entomologist, Durham, N. H., Professor A. E. Stene, State Entomologist, Kingston, R. I.; Dr. Henry T. Fernald, Professor of En-

tomology, Agricultural College, Amherst, Mass.; Mr. W. R. Walton, U. S. Bureau of Entomology, Washington, D. C.

The following resignations from the U. S. Bureau of Entomology have been announced recently: D. M. Dowdell, Jr., Mexican bean beetle project, to accept a position as instructor at the Mississippi Agricultural and Mechanical College; T. H. Frison, J. H. Painter, C. W. Rieman, 3d, and G. E. Spencer from the Japanese beetle laboratory, Riverton, N. J; Albert H. Amis, junior entomologist associated with A. O. Larson, bean weevil investigations, Alhambra, Calif., resigned September 25, to accept a position in Sinaloa, Mexico, under the direction of Dr. A. W. Morrill; temporary employees, boll weevil control: John R. Cole, R. C. Dancy, S. B. Hendricks, L. P. Hodges, E. F. Holley, J. E. Humphries, A. L. Monroe, W. D. Reed, Paul D. Saunders, A. Schultz, T. L. Wilkerson; tobacco insect investigations: E. F. Haden, L. N. Judah, M. L. MacQueen, H. C. Plummer, T. P. Weakley, W. B. Weakley.

The following statement regarding the progress of the campaign against the Argentine ant in New Orleans appeared in Florists Exchange for September 30, 1922:—"Virtually 3,000 blocks had been covered by the poisoners in the local ant extermination campaign when operations were suspended at the end of this week; the major part of the more heavily settled portions of the city lay blanketed with 350,000 cans of the compound. The indications are that the scattered portions in the area below Canal St., would be attended to early next week. Uptown the distribution has progressed over a slightly smaller area. In three weeks as much has been performed as it was estimated could be accomplished in five. At the present rate the middle of next month will witness the completion of the task. Temporary suspension may be caused by a lack of sponges needed for the work.

Recent preliminary examinations for the presence of Japanese beetle larvae in fields in the vicinity of the laboratory at Riverton, N. J., show a heavy increase in the number of grubs compared with the number present a year ago this time, in some cases running as high as 100 per cent. or more increase. It is expected that the regular grub survey to be made a little later in the fall will show a general increase in density of grub infestation throughout the infested territory as a whole. A serious injury to a number of the greens in local golf courses, as a result of the abundance of Japanese beetle larvae, has been found. The greens offer ideal facilities for egg depositions by the beetle during the season, and it is quite apparent that the effect of these heavy egg depositions will be serious, possibly necessitating the rebuilding of infested greens.

On September 6th, Messrs. D. J. Caffrey and G. W. Barber of the European Corn Borer Laboratory at Arlington, Mass., maintained by the United States Department of Agriculture, visited the Port Stanley Laboratory, Ont., and investigated the control work being carried on for the European Corn Borer in that region. September 7th and 8th were Ohio days at the Port Stanley Laboratory. A party of forty-three officials, county agents and farmers from the State of Ohio visited the European Corn Borer outbreak in the vicinity of Port Stanley. They arrived from Cleveland on the afternoon of the 7th, coming across Lake Erie on the Ohio Fish and Game Commission boat. The object of the trip, which was organized by the Ohio Department of Agriculture, was to bring to the attention of the farmers and county agents the necessity of co-operative action in sections where the pest was abundant and doing extensive damage. The party was in charge of Mr. L. J. Taber, Director

of Agriculture for Ohio, and included Messrs. E. C. Cotton, Raymond C. Osburn, Herbert Osborn, H. A. Gossard, J. S. Houser, T. A. Parks, and N. E. Shaw. Messrs. W. R. Walton and L. H. Worthley of the U. S. Bureau of Entomology also spent two days at the Laboratory. The visitors were conducted on their trips by Messrs. McLaine, Crawford, and Keenan of the Entomological Branch and Capt. George Spencer of the Provincial Department of Agriculture.

## Pacific Slope Notes

Mr. C. T. Dodds spent the summer in Sinaloa, Mexico, assisting R. H. Van Zwaluenberg in introduction, breeding and liberation of parasites of the sugar cane borers.

Mr. A. W. Morrill of Los Angeles spent the first two weeks of September in the State of Sinaloa, Mexico, in connection with contracts with growers and shippers organizations for advisory services.

Mr. F. H. Wymore, recent graduate in Entomology, University of California, has been appointed as special investigator of the asparagus centipede in connection with work for a Master's Degree.

Mr. Albert H. Amis of the Stored Product Insect Investigations of the Bureau of Entomology, stationed at the Alhambra, California, laboratory, has resigned to accept a position with Dr. A. W. Morrill, consulting entomologist of Los Angeles. Mr. Amis will be located at Los Mochis, Sinaloa, Mexico, the principal vegetable growing and shipping point on the Mexican West Coast, and in addition to entomological advisory services and investigations, will conduct general agricultural experiments relating to plant disease control, fertilizers, irrigation and cultural methods.

Mr. Eric Hearle, Assistant Entomologist in charge of mosquito investigations, Entomological Branch, Canadian Department of Agriculture, is now in the Rocky Mountain Park, Banff, Alta., where a temporary laboratory has been provided by the Dominion Parks Branch of the Department of the Interior. A biological study of the mosquitoes of the region is being undertaken and close co-operation in the control work has been established with the officials of the Park. Mr. Hearle reports that resulting from the spring control work, there has been a decided decrease in the number of adult mosquitoes present. (Accidentally omitted from the October issue although there was editorial reference thereto).

## Horticultural Inspection Notes

Messrs. E. N. Cory of Maryland and W. J. Schoene of Virginia, attended the Bulb Conference held in Washington on October 30, 1922.

Mr. Harvey A. Horton, who has been stationed at Eagle Pass, Texas, for the past two years, was recently transferred to the port of Seattle for the purpose of assisting in ship inspection.

A shipment of 1,000 sacks of walnuts arrived at the port of Vancouver on August 17th and were refused entry by Chief Provincial Inspector Lyne on account of being infested by *Plodia interpunctella*.

Mr. H. H. Willis, in charge of the inspection and fumigation works of the Federal Horticultural Board at El Paso, Texas, has been temporarily transferred to Washington to assist in the inspection of plants introduced under Special Permit.

Messrs. Faustino Q. Otanes and N. G. Tedoro of the Philippine Islands, who have recently completed courses at the Universities of Illinois and Wisconsin respectively, have during the months of October and November been studying the inspection and disinfection methods employed by the Federal Horticultural Board in Washington.

The number of foreign shipments of nursery stock arriving under Special Permit in Washington during the fall shipping season of 1922 is more than double the number received during the same period of 1921. The season opened about two weeks earlier this year than usual. Shipments arriving thus far include orchids, bulbs, herbaceous perennials, and shrubs.

Mr. Lee A. Strong, Chief, Bureau of Plant Quarantine of the State of California, left Sacramento September 1 for the purpose of studying the port inspection methods employed in New York, Boston, Philadelphia, and Washington. While in the east, Mr. Strong visited the Japanese beetle laboratory at Riverton, N. J., and the bean beetle laboratory at Birmingham, Alabama.

Mr. E. R. Sasscer, entomologist in charge of the plant quarantine inspection service of the Federal Horticultural Board, returned the middle of September from an inspection trip of the ports of entry along the Mexican border and the Pacific Coast. During this trip he had conferences with customs officials, port office officials and various state officials, with a view to strengthening the plant quarantine inspection service.

The European Tulip Aphid, *Anuraphis tulipae* Boyer, is found to be present this season, as in previous years, in nearly every shipment of iris rhizomes received from Europe. It is also being found occasionally on Spanish iris bulbs. The insect is apparently quite common in western Europe, having been taken repeatedly on plants from England, France, and Holland. There are only a few records of the finding of this species in the United States, and its distribution may be quite local

Larvae of the Narcissus and Lesser Bulb Flies have been frequently found in Narcissus bulbs from France and Holland during the bulb shipping season, which has just been completed. One shipment consisting of eight cases of French bulbs arriving in New York, which was carefully examined, showed from one to five per cent. of the bulbs to be infested with *Merodon equestris*. A shipment of eighty-seven cases, for the most part Narcissus bulbs, arriving at Philadelphia from Holland, was found to be infested with both *Merodon equestris* and *Eumerus strigatus*. From one hundred to two hundred bulbs, examined in eighteen cases, exhibited an infestation varying from one to twelve and one-half per cent. One bulb examined by Mr. H. L. Sanford was found to contain seventy-seven larvae of *Eumerus strigatus*.

## Dr. L. O. Howard Addresses Louisiana Entomological Society

Dr. L. O. Howard, Chief of the Bureau of Entomology, was the speaker at a meeting of the Louisiana Entomological Society at the Natural History Building, Jackson Square, New Orleans, on October 18th, 1922.

Dr. Howard chose for his subject the idea that all entomologists are economic entomologists. Formerly, especially in Europe, collectors and systematists held the view that theirs is the only true science of entomology. This opinion has now changed until there is danger of the economic entomologist setting himself up as the only real scientist as far as entomology is concerned. As a matter of fact, all phases of the science go hand in hand, and all are necessary for good economic work. The value of the systematist is illustrated by the discovery this spring of a new potato weevil in southern Mississippi. This was sent to the Bureau of Entomology by the Mississippi State Plant Board, it was identified by the museum workers, the probable country of its origin was ascertained, references to previous studies were found, and before any information could be obtained by experiments in Mississippi a great deal was known of the new enemy to potatoes.

In the war against insects, as in every other conflict, it is necessary to know what we are fighting. This information is supplied by the systematic worker, who should by no means be looked down upon by the economic entomologist and the general public as a bespectacled individual examining dead specimens through which he has thrust pins, but should be accepted as an ally and an important one in the battle.

Dr. Howard delighted his audience with entomological reminiscences told in his own inimitable style. The customs and the membership of the various entomological societies of this country and Europe were compared. Dr. Howard then answered questions on a number of subjects, and a sort of conversazione followed.

At its conclusion the members, though deeply conscious of the fact that they were honoring their Society rather than conferring any additional renown on Dr. Howard, unanimously elected him to honorary membership.

The meeting was attended by the following Members:—Dr. Howard, Messrs. Ed. Foster, R. T. Hobson, W. E. Haley, James M. McArthur, Wm. E. Upton, H. T. Mead, Percy Viosca, E. R. Barber, O. W. Rosewall, T. E. Holloway. Visitors—Mrs. H. T. Mead, Mrs. E. R. Barber, Mrs. T. E. Holloway, Prof. R. W. Harned, Mr. E. K. Bynum, and Messrs. Benedict, Venable, Cunningham and Bertram.

T. E. Holloway,
*Secretary-Treasurer*

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